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APPENDICITIS.

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A TREATISE

ON

APPENDICITIS

BY

JOHN B. DEAVER, M.D.
SURGEON-IN-CHIEF TO THE GERMAN HOSPITAL, PHILADELPHIA

SECOND EDITION, THOROUGHLY REVISED AND
CONSIDERABLY ENLARGED

ILLUSTRATED WITH TWENTY-TWO FULL-PAGE PLATES

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TO THE MEMORY OF MY FATHER,

J. M. DEAVER, M.D.,

WHOSE CHARACTER AND STERLING QUALITIES AS A PHYSICIAN HAVE BEEN THE GUIDING INFLUENCES OF MY PROFESSIONAL LIFE,

This Book is Affectionately Dedicated.

PREFACE TO THE SECOND EDITION.

It is especially gratifying that a second edition of this treatise should have been called for within a comparatively short time after the appearance of the first, and I much regret that stress of other work has necessitated the postponement of its publication for a long time. In its preparation I have been actuated by a desire to detail as concisely as is compatible with clearness the opinions formed as a result of much study and considerable experience at the bedside and the operating table. I have not been unmindful of, nor have I neglected to refer to, the excellent work already done and still being done in this department of surgery by many surgeons both in this country and abroad. The book virtually has been rewritten; every chapter has been carefully revised and much new matter has been incorporated. Especially noteworthy is the chapter on the pathology of appendicitis. This is entirely new, and has been written by my friend and colleague, Dr. A. O. J. Kelly, Director of the Pathologic Institute of the German Hospital. The various additions have resulted in considerable increase in the size of the volume, but this, I trust, will not be deemed detrimental to its value. A number of the plates in the first edition, especially those intended to illustrate various steps in the operation for the removal of the appendix, have been omitted from this edition, under the impression that at most such plates are of doubtful utility. Instead of these there has been substituted a series of plates to illustrate the microscopic lesions of the different varieties of appendicitis. For these I am much indebted to Miss Elizabeth G. Harding. The plates illustrating the ileo-colic, the ileo-cecal, and the sub-cecal fossas are also new.

I may be permitted to state that in writing this treatise I have had constantly in mind the great multitude of conscientious doctors in all parts of the country who are striving to do their best for their patients. I have endeavored to prepare a work that should serve as a reliable guide in the presence of the most serious of all acute intra-abdominal affections and of disorders that more or less resemble it. In the revision I have profited much by the kindly expression of opinions and criticisms conveyed to me both privately and publicly by many of my professional brethren.

My thanks are due to Dr. J. Rex Hobensack, Dr. George G. Ross, and Dr. Leon Brinkmann for assistance in the preparation of the volume, and to Dr. Albert D. Whiting for the preparation of the index. A list of the authors referred to in the text will be found at the end of the volume.

JOHN B. DEAVER.

1634 WALNUT ST., PHILADELPHIA,
May, 1900.

PREFACE TO THE FIRST EDITION.

THE following work on appendicitis has been prompted by the belief that the importance of this affection entitles it to a more thorough and exhaustive study than has usually heretofore been accorded it. Appendicitis in a general way has been so widely and thoroughly discussed that in its usual forms its diagnosis is comparatively devoid of difficulty. No inflammatory affection of the abdominal cavity, however, is capable of such varied symptoms and of so many serious complications, all of which demand the most thorough knowledge for their proper treatment.

It has been my desire to present in this volume such a systematic study of the disease that not only the usual symptoms may be traced from their inception to their termination, but also that the various anomalous conditions so frequently met with may be recognized with equal facility.

I have, therefore, endeavored to emphasize the etiology, symptomatology, and special technic of the operative treatment. The observations herein contained are the result of an experience in the treatment of over five hundred cases.

I wish to express my thanks to my assistants, Dr. L. Brinkmann, Dr. George G. Ross, Dr. A. D. Whiting, my brother, Dr. H. C. Deaver, and to Dr. Wilmer Batt, for valuable aid in the preparation of the book, and to Dr. W. S. Dougherty, my surgical interne at the German Hospital, for preparing many case reports and for correcting all the proof-sheets.

A number of the pathologic drawings were made by Dr. C.

Frese, and to him and to the excellent artistic work of Mr. F. von Iterson is due the accuracy of that series. I wish also to express my grateful acknowledgment of numberless services performed by Dr. Frese, as Medical Superintendent of the German Hospital, where I have done the larger part of the surgical work here represented.

JOHN B. DEAVER.

1634 WALNUT STREET, *June, 1896.*

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APPENDICITIS.

HISTORY.

A review of the history of the inflammatory affection in the right iliac fossa, now recognized as a disease of the vermiform appendix, discloses many facts which account for the diversity of opinion of earlier observers. During the first half of the present century, although cases had been reported in which perforation of the appendix were found, almost all morbid conditions localized in the right iliac fossa were ascribed to disease of the cecum. It is probable that inaccurate knowledge of the distribution of the peritoneum served in part to account for this condition of affairs. The older writers held that this membrane served only as a covering for the solid viscera contained in the abdominal cavity. In the year 1803 Laennec first gave a complete description of the peritoneum. While his investigations stimulated further observation upon this important subject, there was as yet no association of inflammation of the general peritoneum with disease in the right iliac fossa. Indeed, the symptoms of many varieties of what is now known as appendicitis were described with minuteness and accuracy, but neither during life nor after death were the local conditions held to be responsible for the general peritonitis. In fact, the history of appendicitis may be roughly divided into three periods:

1. That in which the more striking lesions, such as perforation and gangrene of the appendix, were recorded as isolated facts of mere pathologic interest;

2. That in which the appendix was regarded as taking a part secondary to the cecum, when either was affected by any inflammatory or ulcerative process;

3. That in which the appendix alone was definitely deter-

mined to be the organ at fault in practically all the acute inflammatory affections limited to the right iliac fossa.

The first authentic record of the distinct localization of a lesion in the vermiform appendix was by Saracenus, in a letter dated August 28, 1642. He described an abscess in the right iliac region with the discharge of fecal matter and fourteen lumbricoid worms. It is likely that this is the oldest case of peri-appendicular abscess on record.

Mestivier, in 1759, reported a fatal case of abscess on the right side of the umbilicus, due to perforation of the appendix by a pin.

Jadelot, in 1808, recorded a case which clinically showed only fever of an adynamic type. At the autopsy four ascarides lumbricoides were found coiled within the appendix.

Wegeler, in 1813, in the case of a young man who suffered from pain in the right iliac fossa, meteorism, and stercoraceous vomiting, found, upon postmortem examination, gangrene of the cecum, beginning at the base of the appendix. No mention is made of peritonitis, but the appendix was considered to have been first involved.

In 1824, Louyer-Villermay reported two cases of fatal peritonitis, due directly to perforation of the appendix. These are the first recorded cases in which the true origin of the disease was recognized.

In 1827, Husson and Dance described diseases of the cecum in considerable detail.

But Melier was the first to draw conclusions from a number of observations. In 1827, he reported eight cases, three of which he described as cases of perforative appendicitis with fulminating peritonitis, while one was a case of relapsing appendicitis. Both Louyer-Villermay and Melier, however, believed that disease of the appendix and of the cecum were separate and distinct. Melier described the appendicular disease very fully, and made special mention of two distinct symptoms in the perforative cases: viz., more or less severe abdominal colic and fixed pain in the right iliac fossa. He considered the causes, the character, and the consequences of appendicitis, and even anticipated the possible advantage of operation. He said: "If it were possible to establish with certainty the diagnosis of this affection, we could see the possibility of curing the patient by operation. We will, perhaps, some day arrive at this result."

In 1831, Ferrall published a monograph on "Phlegmonous Tumors in the Right Iliac Fossa." In this he held that in these conditions the cecum is the organ primarily involved, and that the appendix and the peritoneum do not enter as factors into the production of the phlegmon to so great an extent as does the retro-cecal connective tissue. He recognized three varieties of tumors: (1) Fecal impaction or distention of the cecum without inflammation; (2) malignant tumor of the cecum; (3) a true inflammatory or phlegmonous tumor, the result of irritation of the mucous membrane of the cecum, or of ulceration and perforation of its wall. Ferrall also mentioned a thickened condition of the peritoneal covering of the cecum which was associated with the phlegmonous tumor.

In 1833, Dupuytren recorded observations which showed the connection between abscess of the right iliac fossa and disease of the cecum, and it was largely due to this authority that the cecum was so generally accepted as the primary site of perityphlitis. In Dupuytren's necropsy-reports no mention is made of the appendix as the original site of the disease, and nowhere in his writings did he consider the appendix as the cause of inflammation of the cecum.

In 1834, Copeland made an advance in the pathology of the diseases of the right iliac fossa. He entered upon the study of the diseases of the cecum in great detail, and claimed that inflammation of the appendix could be the primary cause of serious affections in the region of the cecum. He also spoke of "mortification" of the appendix from a foreign body within its lumen, followed by fatal peritonitis.

In 1837, Burne strove to separate clinically diseases of the appendix from those of the cecum, although he agreed with the writers of that time, that in affections of the right iliac fossa the cecum was the primary site of the disease. He mentioned ulceration of the appendix due to morbid processes set up by foreign bodies, such as cherry-stones, raisin-seeds, and fecal concretions, and added: "So long as ulceration is limited to the mucous membrane, it is of little consequence; but as soon as the peritoneum is perforated, inflammation ensues; then there is general peritonitis, or local peritonitis with abscess." In 1839 he wrote a second paper, in which he endeavored to show that the cecum was of little importance in the affections of the right iliac fossa.

In 1838, Albers noted the possibility of the occurrence of disease of the right iliac fossa as the result of inflammation of the vermiform appendix, but he thought that it was more frequently caused by disease of the cecum. Under the name "typhlitis" he described the following varieties of inflammation localized about the cecum:

1. Stercoral typhlitis—stagnation of fecal matter in the cecum, with subsequent irritation;
2. Simple typhlitis—catarrhal inflammation due to a multiplicity of causes;
3. Peri-typhlitis—extension of the inflammation of the mucous membrane to the external coat of the cecum and the surrounding tissues;
4. Chronic typhlitis—in which the course of the disease was slow and prolonged. When pus was present, and was associated with a perforated appendix, he believed that the perforation occurred as a consequence of the pus formation.

Grisolle, in 1839, reported sixty cases of phlegmonous tumors in the right iliac fossa, twelve of which had come under his own observation. His principal contention was that inflammation of the ileo cecal mucous membrane did not extend beyond the cellular layer, and hence could not produce the phlegmonous tumors hitherto ascribed to this cause. He believed that perforation of the cecum and appendix occurred spontaneously, and that they were the result of a gangrenous process set up by foreign bodies and fecal concretions.

In 1840, Villermay reported cases of inflammation of the appendix which rapidly terminated in gangrene and death.

In 1843, Voltz published a paper on "Ulceration and Perforation of the Appendix Occasioned by Foreign Bodies." His general conclusions were that the appendix was responsible for more of the affections of the right iliac fossa than was the cecum.

Rokitansky, in 1855, was the first to consider catarrhal inflammation of the appendix to be due to fecal concretions or foreign bodies, and he believed that this inflammation might result in ulceration or persist as a chronic morbid condition. Indeed, this theory of chronicity constitutes the most important part of Rokitansky's article, as his predecessors had considered only the extremes of gangrene and perforation. He referred to obliteration of the appendix, as well as to its cystic degeneration, in some favorable cases; and, further, indicated that both typhoid and tuberculous processes, with or without subsequent perforation, might take place in the appendix. He also suggested that a general peritonitis does not necessarily develop as a consequence of perforation of the appendix, because the general peritoneal cavity may be protected by adhesions to the surrounding structures formed prior to the perforation. He thought these adhesions were due to a previous irritation.

Although the view that the grave and fatal forms of typhlitis were due to perforation of the appendix gained ground, yet all the benign and curable forms were considered to be inflammations of the cecum and of the surrounding cellular tissue.

Hancock, in 1848, operated on one case. He advocated early operation in disease of the appendix, but his ideas met with no encouragement.

Lewis, in 1856, and Bamberger, in 1858, considered that mild forms of inflammation in the right iliac fossa were of cecal origin, but that severe inflammations began in the appendix. Lewis made an unfavorable prognosis in almost all cases, but the importance of his paper is due to the fact that he recommended early and thorough surgical treatment when a tumor was present, even though no fluctuation could be demonstrated.

Leudet, in 1859, remarked that perforation of the appendix was more common than perforation of all other parts of the intestine, and that such perforations may open into the cecum, rectum, vagina, or bladder, or through the abdominal wall.

He also stated that hepatic abscess and pylephlebitis might occur as complications of the disease. He renounced the theory of the origin of appendicular inflammation in the cecum.

In 1866, Willard Parker, of New York, first proved that early operation would save seventy-five per cent. of all cases. He advocated operation between the fifth and twelfth days.

Gouley, in 1875, recommended operation even earlier, in order to prevent rupture into the peritoneum.

Wilkes and Moxon, in 1875, stated that the appendix was usually at fault, but that inflammation and perforation of the cecum, producing abscess and peritonitis, did occur.

C. With, of Copenhagen, in 1880, was probably the first to deny that peritonitis was ever caused by typhlitis.

In 1883, F. F. Noyes reported 100 cases operated upon, ninety per cent. of which operations had been performed in America.

Ziegler, in 1885, discussed appendicitis under the name typhlitis.

"The epoch-making memoir of this subject is the paper of Reginald Fitz, of Boston, published in the '*American Journal of the Medical Sciences*' for October, 1886, 'On Perforative Inflammation of the Vermiform Appendix.' In this work Fitz collected reports of 209 cases of typhlitis and peri-typhlitis, and 257 cases of perforative appendicitis. He shows that the symptoms are the same in the latter as in the former class of cases. He studied with care the consequence of perforation. He established the fact that the peritonitis is not always generalized, and that it may be circumscribed under the form of an encysted, purulent collection. He gave the characters of the tumors formed by this localized peritonitis; the different modes of the evacuation of the pus; the complications that may supervene if the disease be left to itself. He insisted on the frequency of fecal concretions as a cause of perforation of the appendix. He concludes in favor of early operations" (Talamon).

Fagge, in 1886, quoted Wilks as having stated that the disease always began in the appendix.

In 1888, Fitz published a second paper, in which he advanced the radical but sound theory that the diseases described as typhlitis, peri-typhlitis, para-typhlitis, appendicular peritonitis, and peri-typhlitic abscess were all varieties of one and the same affection: namely, appendicitis.

Since 1888, in which year Sands reported the first successful removal of the appendix for acute appendicitis, the subject of appendicitis has occupied a large proportion of the time and labor of the medical profession, and there have been published many able papers which advance widely different views and ideas in regard to it. The diagnosis and treatment have been the points most debated; about these the discussion has been waged, generally with the physicians opposing the surgeons.

To McBurney's paper, read before the Medical Society of the State of New York in 1891, belongs the credit of bringing the early surgical treatment of appendicitis into prominence. He reported twenty-four early operations in serious cases with only one death.

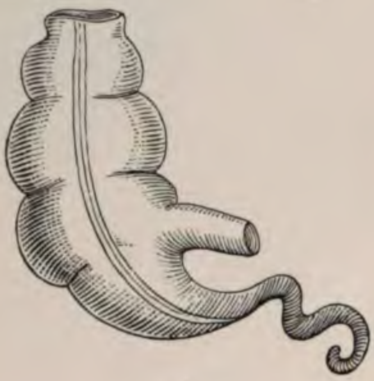
Osler, in 1892, published the first text-book in which nearly all cases of typhlitis were directly stated to be appendicitis.

Pepper, in 1894, said that the majority of cases of acute disease in the right iliac fossa were appendicitis.

The frequency of the affection; the rapidity with which the disease may proceed from bad to worse; the fatality in a large percentage of cases; its marked tendency to occur or to recur in those who apparently recover from an attack—these facts make appendicitis the most important intra-abdominal lesion. Assisted by Fitz, the surgeons of the United States have demonstrated by early operation that practically every case of inflammation of the right iliac fossa is due to disease of the vermiform appendix, and have restored this moot question to the status to which Melier advanced it. The work of McBurney, Richardson, Murphy, Price, Fowler, Morris, and others has greatly increased our knowledge of the affection, and has done much to present the subject in such light that both the physician and the surgeon have been enabled to cope with the disease in a satisfactory and life-saving manner.

In the interests of purity of nomenclature the designation "appendicitis"—a compound of a Latin root and a Greek suffix—is open to great objection. In lieu of this philologic barbarism several substitutes have been proposed. Thus, *appendicular inflammation* has been suggested, but is objectionable because there are several appendices. Of suggested mononyms, *apophysitis* can not be employed, because there are several apophyses. Morris has proposed *ecphyaditis* (ἐκφυάς, Galen's word for the vermiform appendix, and ιτις, inflammation), a thoroughly good term. Küster proposes *epityphlitis*, but to justify it has been obliged to coin a new Greek word, ἐπιτυφλόν (ἐπι and τυφλόν), to indicate a structure that surmounts the cecum. Some time ago Gerster drew attention to the word *scolecoiditis* as the only correct designation philologically, and *skolikoiditis* has been proposed and used, to the entire exclusion of appendicitis, by Nothnagel, who states that the vermiform appendix is thus styled in Greek anatomy: σκωληκοειδὴς ἀπόφυσις (σκωληξ, worm). In addition, Dr. Achilles Rose states, on the authority of Dr. Theodore Zaïmis, of Patras, Greece, that the term scolecoiditis is in use in Greece to-day to indicate the affection we designate appendicitis. *Scolecitis* and *helminthitis* have also been proposed, but it seems that scolecoiditis is the desirable word to employ. Appendicitis, however, has become so incorporated in our nomenclature that, desirable philologically as it is to do so, it appears almost impossible to dislodge it.

PLATE I



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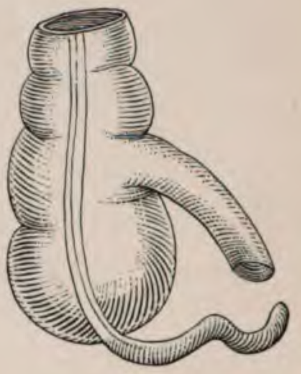

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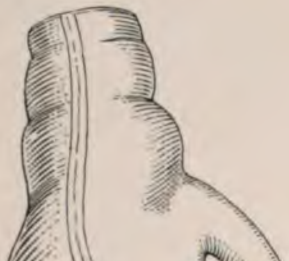

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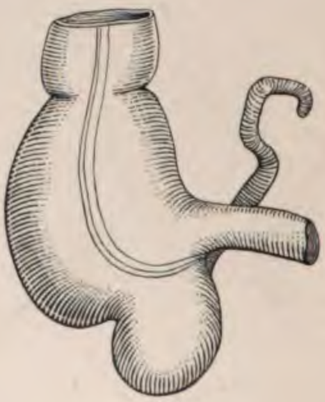

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ANATOMY.

The vermiform appendix of man is the partly developed lower end of the cecum, which does not undergo the same degree of growth and distention as does the upper portion of the cecum. In the embryologic development of the human intestinal tract there is at first no cecum present. The original tract consists of a straight tube, which has been divided into the foregut, midgut, and hindgut. Each division gives rise to different structures. From the midgut springs a diverticulum, which marks the point of division between the large and the small intestine. This diverticulum, which constitutes a conoid projection, lengthens to form the cecum, " but the terminal portion does not keep pace with the growth of the base, and consequently becomes much narrower in caliber. The basal portion eventually grows so large that it is commonly called the cecum, while the true cecum is designated the vermiform appendix." During the early stages of intra-uterine life the cecum, with the vermiform appendix, lies near the umbilicus. Its descent into the right iliac fossa occurs at about the sixth month.

Types of Cecum.—In the adult the cecum develops as one of four types, and in each class the appendix holds a different position. (Plate I.)

I. In the fetal type the appendix is the narrow inferior end of the conoid cecum, the apex of the cone being directly continued into the appendix.

II. A second type consists of a cecum with two equally large sacculi at its inferior termination. The appendix arises from the lower end of the cecum, between the sacculi, which are separated by the anterior longitudinal band.

III. In the third class the external sacculus is large, while the internal one is small, thus bringing the base of the appendix nearer the ileo-cecal valve. In addition, the anterior wall of the cecum grows more rapidly than the posterior, so that the root of the appendix is posterior.

IV. In the fourth and last class the internal sacculus has disappeared entirely, and the base of the appendix is attached to the cecum posterior to the receding angle between the ileum and cecum.

The first type of the cecum is very rare; the second is not commonly seen; and the cecum is usually of the third type, or partakes of the character of both the third and fourth classes. According to Bryant's statistics, in more than one-half of all cases the appendix arises from the posterior surface of the cecum about one inch below and to the right side of the ileo-cecal valve; and in nearly all cases the root of the appendix is upon the postero-internal portion of the cecum, from ¾ of an inch to 1½ inches from the ileo-cecal valve. Observations in the dissecting room and at the ŏperating table, nevertheless, have proved to the author that the cecal attachment of the appendix is almost always upon the postero-internal portion of the cecum. There are, however, rare instances in which the appendix arises from the anterior surface of the cecum.

In cases of nondescent of the cecum the appendix holds a correspondingly abnormal position, and under such circumstances it may even lie to the left of the median line. Lennander mentions the case of a boy, aged sixteen years, in whom the cecum and appendix were found in the left hypochondriac region, lying against the spleen. In this case the appendix measured nine inches in length.

Length and Diameter of the Appendix.—Although the average length of the appendix is from 8 cm. to 9 cm., its length may vary from 1 cm. to 23 cm. When the appendix is long, the cecum is, as a rule, somewhat shortened. The diameter of the appendix is that of a goose-quill, or about that of a large earthworm (Holden)—from 3 mm. to 5 mm.

Peritoneal Coat of the Cecum and Appendix.—The cecum is usually almost completely covered by peritoneum. Its anterior surface is entirely invested by a serous covering; a small area on the posterior surface, however, is frequently left uncovered by the divergence of the two layers of the proximal portion of the meso-appendix. The peritoneum usually covers the appendix throughout, except when the latter lies behind or upon the outer side of the cecum in the subperitoneal areolar tissue. Except when the appendix occupies the positions just mentioned, the peritoneum forms for it a mesentery, or meso-appendix.

The **meso-appendix** is a double layer of peritoneum which is derived from the under or left layer of the mesentery. It usually extends to the tip of the organ, but may extend along only the proximal one-third or two-thirds of the appendix. The meso-appendix is triangular, the base of the triangle being at the free edge. It usually appears to be too short for the organ, thus twisting, curving, or coiling it. The form of the proximal portion of the meso-appendix varies slightly according to the type of cecum. When the cecum is of the first or second type, the proximal part of the meso-appendix is continued as the meso-cecum, the left layer of which is continuous with the under layer of the mesentery, and the right layer with the outer layer of the ascending meso-colon. The upper portion of the posterior surface of the cecum is left bare of peritoneum by the divergence of the two layers of the meso-cecum. In the third type, or in types which are intermediary between the third and fourth, the meso-cecum appears at first sight to be absent. Search reveals it, however, formed by the diverging layers of the proximal portion of the meso-appendix passing to join the under layer of mesentery on the one side, and the outer layer of the ascending meso-colon on the other. The more nearly the cecum approaches the fourth type, the less distinct becomes the meso-cecum. In this type the meso-appendix arises entirely from the under layer of the mesentery, and the proximal part of its right layer is continuous with the serous coat of the cecum and with the peritoneal lining of the iliac fossa—the junction of the last-named two portions of peritoneum forming the outer layer of the meso-cecum. In addition, as the form of the cecum approaches the fourth type, its freedom of motion increases. At operations for their excision, appendices of this type are more easily brought out through the abdominal wound than are those of other types. As the two layers at the proximal portion of the meso-appendix diverge, they leave at the root of the appendix a small triangular area not covered by peritoneum. A perforation of the appendix occurring here or in the line of attachment of the meso-appendix would open into the interval between the two layers of the meso-appendix. As a consequence, in the event of such perforation, pus may pass into the mesentery, and thence to the subperitoneal areolar tissue of the iliac fossa; or at the proximal portion of the meso-appendix the pus may enter the post-cecal areolar tissue, and thence gravitate to the iliac fossa; or, rarely, it may burrow upward behind the colon and simulate abscess of the perirenal fat.

Between the two layers of the meso-appendix are the appendicular artery, vein, and lymphatics, some sympathetic nerves, areolar tissue, and fat.

When adhesions are absent, the mobility of the appendix depends upon the width of the meso-appendix and upon the length of its attachment. Rarely, the meso-appendix is absent and the appendix is freely movable in the abdominal cavity. At times an opening, in which a coil of small intestine has been known to have become caught, to form a hernia, and to have become strangulated, may be found in the meso-appendix.

In some cases the iliac vessels pass through the layers of the meso-appendix. This anatomic condition probably accounts for the manner in which collections of pus in the right iliac fossa may find their way beneath Poupart's ligament into the thigh. In the female the meso-appendix has running to the ovary a prolongation, which is described by Clado as the appendiculo-ovarian ligament. It conveys an additional supply of blood to the appendix.

Position of the Appendix.—In the majority of cases the appendix holds one of eight positions. Dr. Bristow suggests a very simple method of classifying these positions and directions. This consists in locating in the right iliac fossa a central point which represents the most frequent position of the attachment of the appendix to the cecum; from this central point are drawn lines which radiate in eight different directions. To indicate the course of the different lines, Fowler has modified this method by substituting the initial letters of the points of the compass for the numbers used by Bristow. The central point is located by drawing a line from the anterior superior spine of the ilium to the umbilicus; a point on this line, from 2 to 2½ inches from the anterior superior spine, marks the position of the root of the appendix and is the central point from which the lines are drawn.

Although the appendix may occupy any of the eight positions of the points of the compass, it is most commonly found in one of the following: (1) It may lie under the inferior layer of the mesentery, being directed toward the spleen—in the N.E. position; (2) it may lie on the ilio-pectineal line or may project into the pelvis, its course being S. or S.E.; (3) if there be a long meso-appendix, it may lie to the right of the cecum and the ascending colon, running upward, in a northerly direction, parallel with the colon and over the kidney toward the right lobe of the liver; (4) it may lie in front of the colon and cecum, its course generally being N. or N.E.; (5) it may lie behind the cecum, holding generally a northerly direction; (6) if the appendix have a long and wide mesentery, it may be directed toward any of the other points of the compass, freedom of motion generally being required in order that it assume any of these positions; (7) when the meso-appendix is short, the appendix may be coiled upon itself.

Abnormally, the appendix may hold a position in either of the ileo-cecal fossæ; it may lie behind the peritoneum and behind the cecum and may be in contact with the posterior muscular wall of the latter (see Plate v), being covered in this position by the peritoneal coat of the cecum; it may be adherent to the peritoneum along the right border of the cecum and ascending colon or at any point in the neighborhood of the cecum; or it may lie in the inguinal canal.

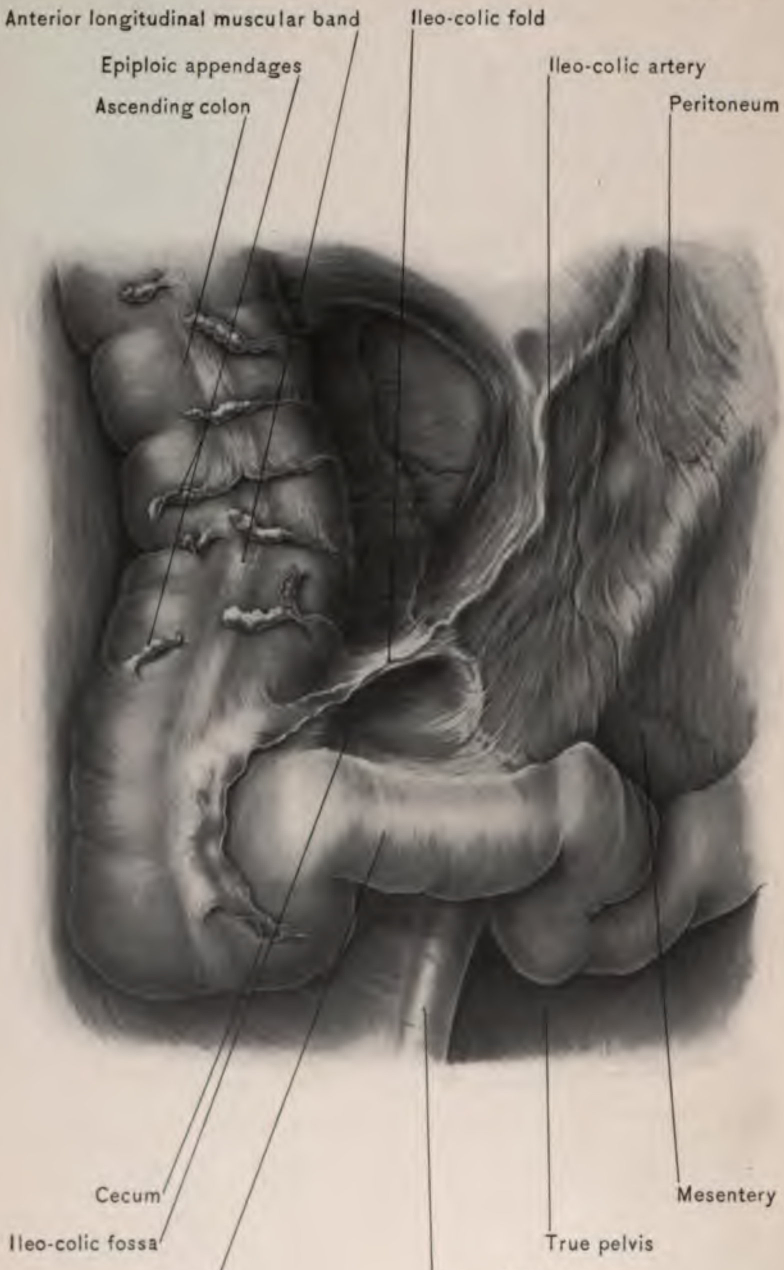
It seems more simple and practical, however, to classify the positions of the appendix as follows: (1) Upward or upward and outward, lying in front of, behind, or upon the outer or inner side of the cecum; (2) under the mesentery and directed upward and inward, inward, or downward and inward over the brim of the pelvis; (3) coiled upon itself and lying under the cecum; (4) downward, lying free in the abdominal cavity under the cecum; (5) outward, lying in front of or behind the cecum.

When the appendix is directed upward or upward and outward, and lies behind or upon the outer side of the cecum, an abscess resulting from disease of that organ frequently produces its local manifestations in the loin and simulates abscess of hepatic or renal origin. When the inflamed organ is directed downward and inward or downward into the true pelvis, the bladder or the ovaries are irritated. The following are from statistics collected by Bryant in the dissecting room from 144 subjects: The appendix held one of the upward positions in relation with the cecum in 11 cases, or in less than 8 per cent.; it was under the mesentery and directed upward and inward, inward, and downward and inward in 92 cases, or about 64 per cent.; it was coiled upon itself under the cecum in 1 case, or less than 1 per cent.; it was directed downward or downward and outward or lying under the cecum in 38 cases, or less than 3 per cent.; it was directed outward in 2 cases, or less than 1½ per cent.

My own observations in the dissecting room confirm the above statistics: that is, positions of the appendix under the mesentery are most common. At the operating table, however, I have found the upward positions in relation with the cecum to be very frequent.

The **structure of the appendix** is very similar to that of the large intestine, but differs somewhat from the latter. The appendix has a mucous, a submucous, a muscular, and a serous coat.

The *mucous membrane lining the appendix* is composed of a delicate retiform connective tissue which contains numerous lymphoid cells within its meshes, and is furnished with a plentiful supply of solitary glands and glands of Lieberkühn. The latter vary greatly in size and number, and are sometimes entirely absent. The retiform tissue is lined with a basement membrane upon which is a layer of columnar epithelial cells. Within the cecum there is seen a prominence of the mucous membrane, which partly or completely surrounds the orifice



Ileo-colic Fossa.

of the appendix, and which is produced by an increase of the lymphoid tissue. This, under certain circumstances, may act as a valve (Gerlach's valve), and may favor occlusion of the orifice. Between the mucous and the submucous coats there may occasionally be distinguished a thin layer of circular muscular fibers—the *muscularis mucosæ.*

The *submucosa* is formed of fibro-elastic areolar tissue, is much denser than the mucous coat, and contains numerous lymphoid glands. In the submucosa are also numerous small arteries and veins which supply the mucous membrane; it generally contains a small quantity of fat.

The *muscular coat* consists of two layers. The inner is a thick layer of circular fibers which at times constitute fully one-third of the entire thickness of the appendicular wall. The outer layer is composed of longitudinal fibers. It is not so thick as the inner layer, nor are the muscular fibers so regular. At times they are bunched at certain points in a manner similar to the fibers of this layer in the cecum.

The *peritoneal coat,* or serous covering of the appendix, is similar to the peritoneal covering of other organs. Its extension upon the appendix has already been described.

The vascular supply of the right iliac fossa is derived from two loops formed by anastomosis of branches of the superior mesenteric artery. One loop is formed by the anastomosis of the descending branch of the right colic artery with the ascending branch of the ileo-colic, and the other by the junction of the descending branch of the ileo-colic with the terminal branch of the superior mesenteric artery. From these primary loops secondary loops are given off, and from these are derived the arteries to the appendix and the ileocecal region. The branch to the appendix—the appendicular artery—passes along the free edge of the meso-appendix, if that structure be present. In the absence of the meso-appendix, the artery usually passes outward upon the appendix beneath its peritoneal coat. In exceptional cases the artery may pass through the meso-appendix directly to the tip of the appendix, in which instance it will not give off branches until it has entered the submucosa. In the female, at times, there is an additional supply of blood brought from the ovarian artery to the appendix through the folds of the appendiculo-ovarian ligament.

The **lymphatics of the appendix** pass to a chain of glands in the angle formed by the junction of the appendix with the cecum. The lymphatics may empty into those of the ovary by passing along the appendiculo-ovarian ligament, in this way forming a communication between the appendix and the ovary.

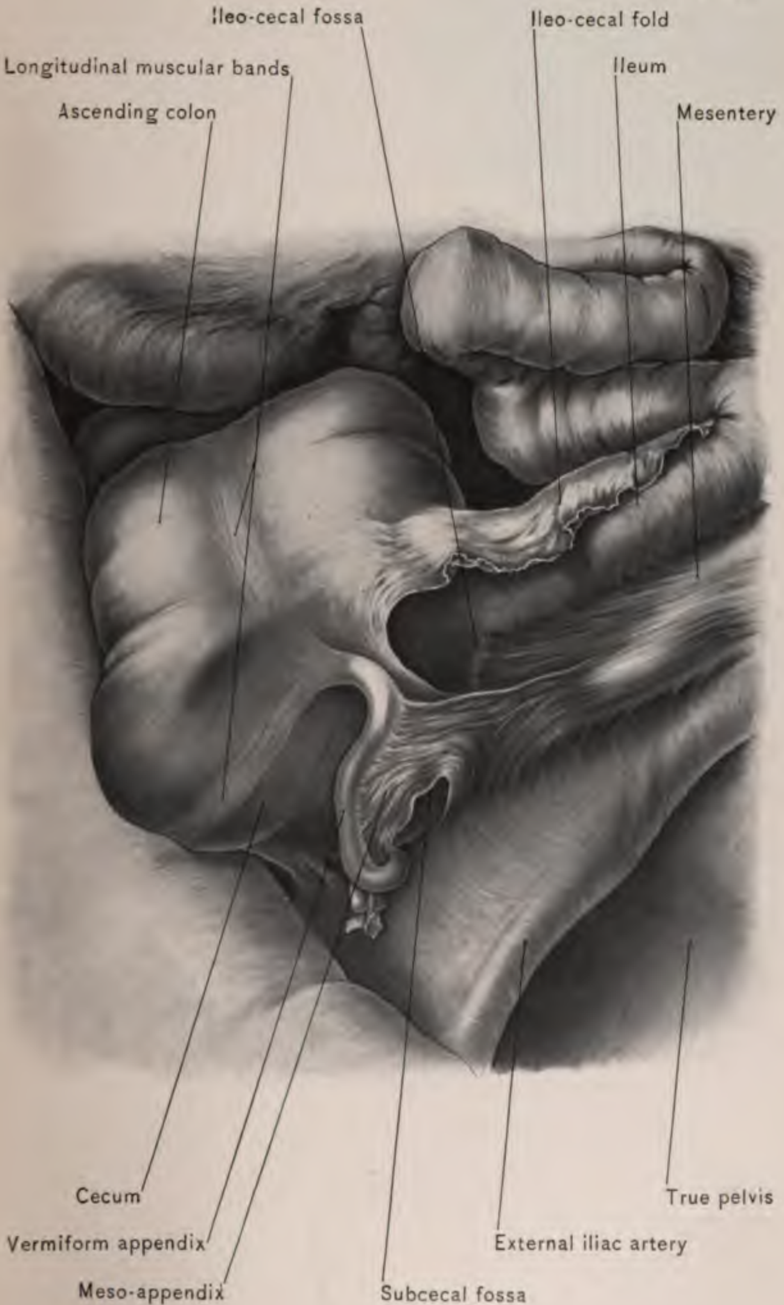
The **nerves of the appendix** are derived from the superior mesenteric plexus of the sympathetic nerve, the branches of the plexus, which accompany the ileo-colic artery, sending filaments to the appendix. As this plexus gives numerous twigs to the small intestine, it is readily understood how pain, due to disease of the appendix, may be referred to the whole abdomen or to any region of it.

Peritoneal Fossæ.—Through the various angles and projections of the cecum and the ileum, fossæ are formed by the reflections of the peritoneum associated with these parts of the intestinal tract; and because of their close relation with the appendix, these fossæ may play an important rôle clinically in inflammation of that organ. Lockwood and Rolleston first called attention to these fossæ and have so carefully described them that I give their description: They are three in number —the ileo-colic, the ileo-cecal, and the sub-cecal.

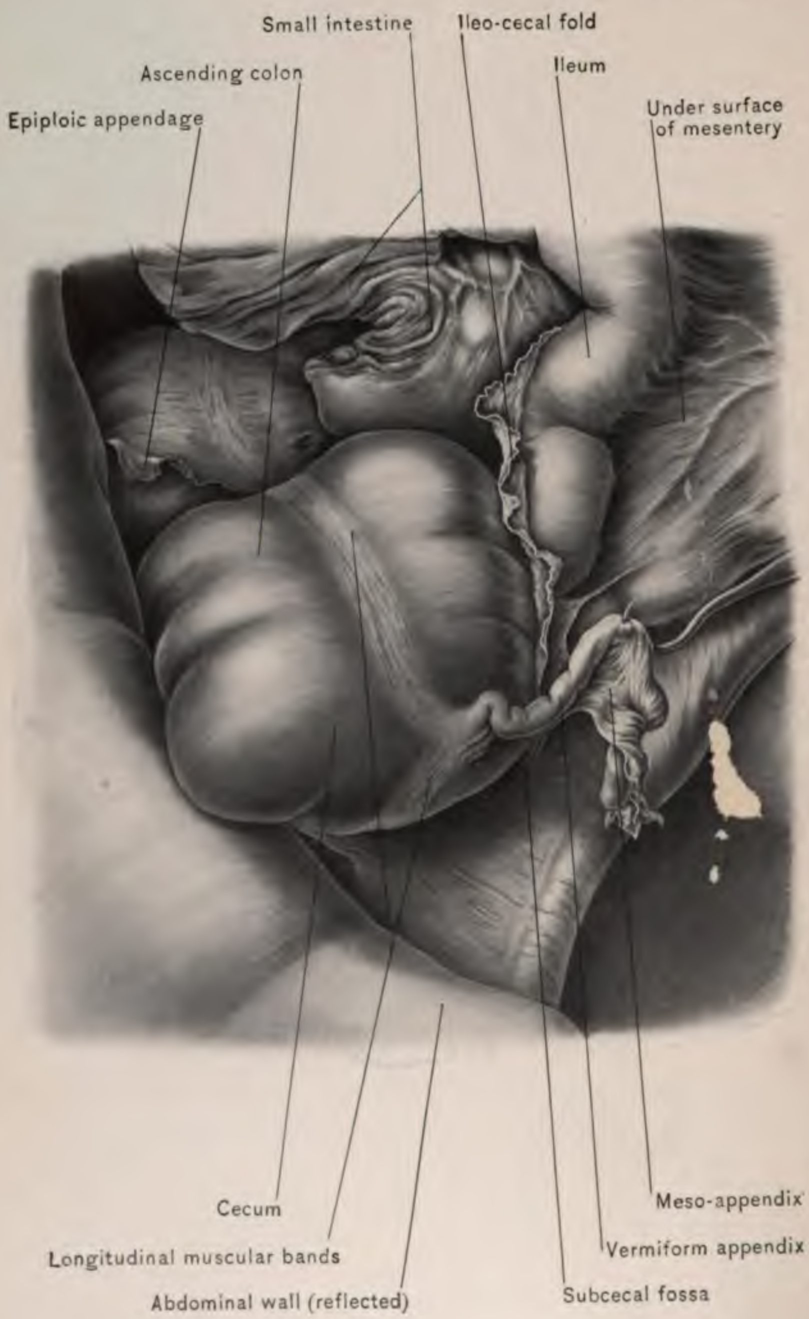
The *ileo-colic fossa* (Plate II) is a peritoneal pouch situated in front of the mesentery in the angle formed by the junction of the ileum and the colon. The floor is formed by the mesentery and sometimes also by a portion of the ileum. The ileo-colic fold of peritoneum forms the upper boundary of the fossa, and sometimes a partial roof. This pouch is variable in size and depth, and on account of its elevated position, does not play a very important part in appendicitis.

The *ileo-colic fold* is a ridge in the peritoneum of the anterior surface of the mesentery and is formed by a branch of the ileo-colic artery which runs through the ileo-colic fold and passes in front of the termination of the ileum.

The *ileo-cecal fossa* (Plate III) is a peritoneal pouch situated



Ileo-cecal Fossa.

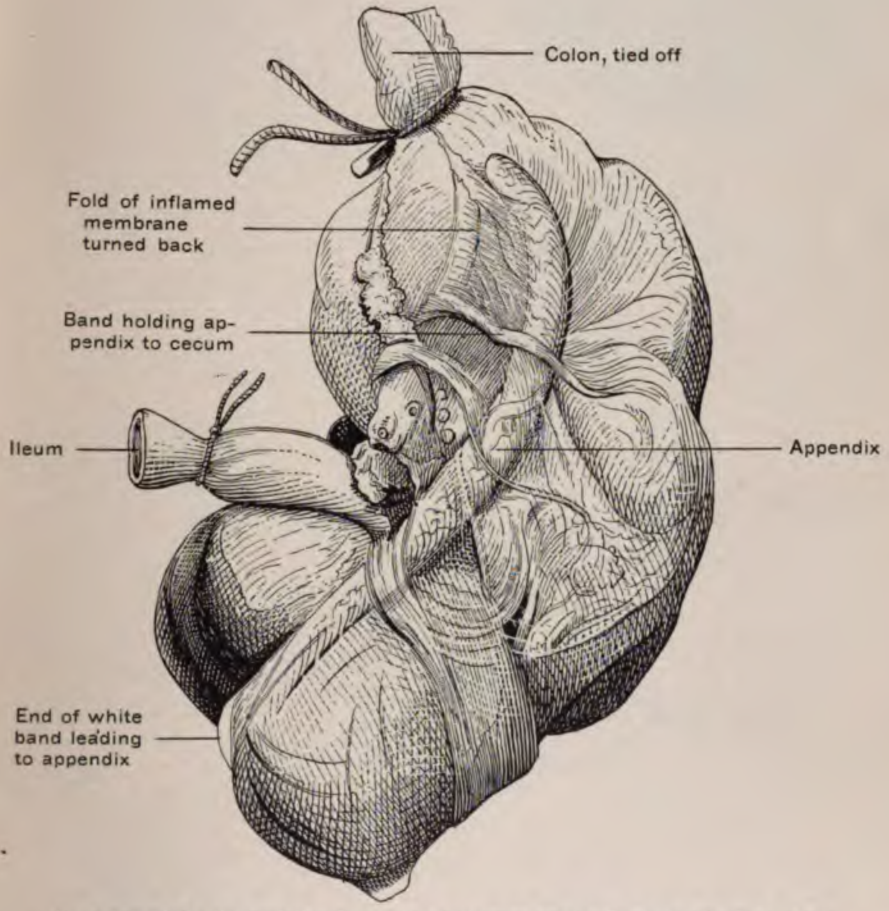


Subcecal Fossa.

behind the angle of junction of the ileum and cecum. To expose it, both the ileum and the cecum must be elevated. It is bounded on the right by the mesentery of the ascending colon, and on the left by the mesentery proper. The roof is formed by the *ileo-cecal fold*, a bloodless fold of peritoneum which extends from the free border of the ileum to the cecum and finally joins either the surface of the meso-appendix or the under surface of the mesentery near the attachment of the meso-appendix. This fossa may be very deep and long, and at times may extend upward behind the ascending colon as far as the kidney and duodenum. The mesentery of the appendix sometimes divides the fossa transversely, thus forming two fossæ, known as the superior and inferior ileo-cecal fossæ. The ileo-cecal fossa is important, as the appendix is usually found in relation with it, thus explaining why this location is often the site of certain products of appendicular disease. Consideration of the description of the meso-appendix and meso-cecum induces the author to bound this fossa as follows: on the right, by the cecum, meso-cecum, and meso-appendix; on the left, by the mesentery; and above, by the ileo-cecal fold and the ileum.

The *sub-cecal fossa* (Plate IV), as its name implies, is immediately under the cecum, and this portion of the bowel must be raised in order to view it. It is less constantly present than the other fossæ. Its mouth is found behind the junction of the cecum with the colon, and the fossa here separates the meso-colon into two double folds. On account of its elevated and external position, clinically it does not play a prominent part. If, however, a meso-cecum were always present, this fossa would be a very important one, as the mouth of the fossa would then be flush with the tip of the cecum, at the base of the appendix. Lockwood and Rolleston have described this condition as occurring, but I have never seen such a case. I prefer to describe the sub-cecal fossa as a depression in the peritoneum situated beneath the cecum, and below and external to the meso-cecum and meso-appendix.

The appendix may occupy any of these fossæ, but it is commonly found in the ileo-cecal or the sub-cecal fossa. On account of the various complications that may arise if the appendix occupy any of these fossæ, the operator may be led to form an incorrect conception of the true state of affairs. Thus, at times the appendix may constitute a retroperitoneal hernia; or, if the appendix occupy one of these fossæ, and the mouth of the fossa should close over it, the organ might be thought to be absent. Suppuration of an appendix so walled in would be entirely circumscribed.


Colon, tied off
Fold of inflamed membrane turned back
Band holding appendix to cecum
Ileum
Appendix
End of white band leading to appendix

An Unusual Position of the Appendix—Adherent to the Posterior Surface, and Covered by the Serous Coat, of the Cecum.

CLINICAL ETIOLOGY.

The etiology of appendicitis may be appropriately divided into the clinical etiology and the pathogenesis; the latter will be discussed in the chapter on the pathology of the affection. From the clinical point of view, the etiologic factors are either predisposing or exciting, or both.

Of the **predisposing causes,** the most important are age, sex, nationality, season, previous attacks of appendicitis, and certain other diseases. Of the **exciting causes,** the most important are exposure, disturbances of digestion, traumatism, and certain other diseases. Under different circumstances, some of the latter may act as both predisposing and exciting factors.

Age is a predisposing cause of moderate importance. Although appendicitis is most common in individuals between ten and thirty years of age, about fifteen per cent. of all cases occur in persons under fifteen years. The youngest patient in whom I have encountered the disease was less than one year old; the oldest, over seventy years. The marked susceptibility of young adults to appendicitis is dependent, in the first place, upon the numerous disturbances of the gastro-intestinal tract, due to dietary indiscretions, that occur during this period of life; and, secondly, to the proneness to inflammation of the adenoid tissues throughout the body during adolescence. Analogy is found in the predominance of lesions of the tonsils and of the cervical and mesenteric lymph glands during the period of development. Reason for the relative exemption from inflammation of the appendix during advanced life is found, not only in a more judicious mode of life, but also in the atrophy of the adenoid tissue of the appendix. This, in the majority of cases, commences at about the thirtieth year. It may, however, begin earlier or may be postponed until a later period.

Sex is a predisposing cause of considerable importance.

About eighty per cent. of all cases occur in males. The reasons for the relative exemption of females are found in the less frequent exposure to inclemencies of the weather and to other deleterious influences and in the better blood supply of their appendices. Clado has described a fold of peritoneum that extends from the right ovary to the appendix—the appendiculo-ovarian ligament—that carries a blood vessel to the appendix. This, in conjunction with the appendicular artery, furnishes to the appendices of females a better blood supply than obtains in the male—better both in actual quantity and in proportion to the relative size of the organ in the two sexes.

Nationality is not so important an etiologic factor as it was presumed to be some time ago. It seems, however, to be of some importance; or perhaps what we consider nationality in this connection is mere environment. For a time it seemed that appendicitis was disproportionately common in the United States, the number of cases reported in this country far exceeding those reported in Great Britain and continental Europe. Recently, however, in France, Germany, and Austria, and to a less extent in Great Britain, the early stages of the affection have received deserved attention, and the disease is now recognized as of common occurrence. It seems, nevertheless, to be especially common in this country, and this is probably due to well-known and wide-spread dietetic indiscretions, particularly hurried eating and insufficient mastication. Whether those of foreign birth residing in this country who practise temperate habits of eating are less predisposed to the disease than those actively participating in all the phases of hurried American life is not definitely determined.

Season exerts but little influence as an etiologic factor. Appendicitis is probably more common in summer and autumn than it is in winter and spring. The differences, however, are slight, and those that do exist are probably due to the greater frequency of intestinal disorders in summer and autumn than in winter and spring.

Of other diseases that predispose to appendicitis may be mentioned constipation, gastro-enteritis, dysentery, typhoid fever, influenza, rheumatism, saturnism, etc.

Constipation does not play a very important rôle in the causation of appendicitis. Observations of large numbers of cases indicate that the majority of the patients have had a normal condition of the bowel-movements prior to the attack of appendicitis. In some cases of long-continued and marked constipation, however, it is possible that the increase in the virulence of the bacterium coli commune that has been encountered in that condition may be remotely connected with the development of the affection.

Gastro-enteritis with diarreheic attacks is probably of more importance than constipation in the etiology of appendicitis. Indeed, in many cases attacks of indigestion seem to be the direct exciting cause of the disease. The subacute or more chronic gastro-enteritis is probably of significance in that the appendix is prone to participate in morbid conditions that implicate the general intestinal tract. Catarrh of the intestinal mucous membrane may, and probably often does, spread to the lining of the appendix; but such is the mildness of the pathologic alterations that they do not engender any clinical manifestations. At times, however, they may progress, either of their own accord or following the advent of some exciting cause, and an acute attack of appendicitis may supervene. Under other circumstances catarrhal changes of mild degree persist, and lead to chronic catarrhal or interstitial appendicitis, with or without clinical symptoms. At all events, in many cases of chronic appendicitis careful inquiry into the past history of the patient will elicit symptoms of chronic intestinal catarrh, which either may have inaugurated, or may have been inaugurated by, the appendicitis, and which does not subside until after excision of the offending organ.

Dysentery is also of etiologic significance, because of the predisposition of the appendix to participate in lesions of the intestinal tract. These, of course, consist of ulceration, and it is the consequent cicatrices that are of such extreme significance in the subsequent development of appendicitis. The significance of these cicatrices will be dealt with in the section on the pathogenesis.

Typhoid fever is one of the remote causes of appendicitis, and, at times, also one of the direct causes of the affection. It has been proved conclusively that lesions of the appendix are of common occurrence in typhoid fever. For the most part these consist of catarrhal alterations and of swelling, congestion, and edema of the adenoid follicles of the organ. Not uncommonly, however, ulceration occurs, and runs a course precisely similar to analogous conditions in other portions of the intestinal tract; that is, the ulceration may go on to perforation, or regeneration, organization, and cicatrization may follow the ulcerative process. As a consequence of the resultant cicatrix, more or less occlusion of the lumen of the organ may supervene, and, as will appear later, this is one of the most important factors in the subsequent development of appendicitis. In certain cases of chronic appendicitis a history of previous intestinal disorder can readily be elicited. This may consist of intestinal indigestion, vague pains in the abdomen, etc., the origin of which can often be traced to an attack of typhoid fever that may have occurred months or years previously. This is illustrated by the following case:

Miss I. M. W. was first troubled with a mucous discharge from the bowel in the summer of 1889. At this time she had an illness which was attended by frequent watery, and sometimes bloody, stools, and which was called typhoid fever. She was confined to bed for three weeks and made a tedious recovery. Since that time she has been subject to attacks of catarrhal enteritis, which come on at intervals, the longest interval being four months. These attacks, which seemed to be induced by exposure to cold, unusual exertion, sea-sickness, etc., were less frequent in the autumn and early winter, after change of air and rest during the summer, than at any other season. During the intervals she was well. In June, 1893, she had an attack that lasted three weeks. When seen for the first time, vague pains were present in the right iliac fossa and a distinctly enlarged and tender appendix could be palpated. At operation there were no peritoneal adhesions, but the appendix was indurated and contained pus. The mucosa and submucosa were thickened and presented evidences of chronic catarrhal inflammation. Recovery was prompt and uneventful, and was followed by the entire disappearance of the symptoms previously complained of.

Influenza seems to exert a predisposing influence in the production of appendicitis, and this probably because of the intestinal lesions to which it gives rise. These may extend to the lining membrane of the appendix; or such may be the swelling of the appendicular orifice produced that drainage is effectually prevented and appendicitis results; or the influenza bacillus, gaining access to the appendix, may directly excite inflammation of the organ. Of this latter, however, there has as yet been no proof. The prevalence of this disease as a pandemic may account, in part, for the great number of cases of appendicitis seen in recent years.

Rheumatism has been assumed by some to be a causative factor in the production of appendicitis, and several cases of rheumatic appendicitis have been reported. As the evidence at hand seems to indicate that rheumatism is either an infection or an intoxication, it is not unlikely that the organism provocative of the articular alterations may inaugurate disease of the appendix. The probability of this is further enhanced because of the predilection of the rheumatic infective agent for certain adenoid tissues, such as those of the tonsils, and, by analogy, also the tissues of the appendix. Personally, however, I have never encountered a case in which rheumatism and appendicitis were associated, nor one in which tonsillitis preceded the attack of appendicitis.

Lead-poisoning has also been assumed to be an agent of some significance in the causation of appendicitis, and some cases of the concurrent existence of the two affections have been reported. It is presumed that the lead so affects the appendix as to favor infection, or that, of itself, it acts as the irritant to excite inflammation of the organ.

The most important predisposing cause of appendicitis is the fact that the appendix has already been the seat of one or more attacks of the same affection. The reasons for this will be discussed more in detail in the section on the pathogenesis. Clinically, the fact is well established that those who have had one attack of appendicitis are most likely to suffer from others. Of 460 of my own cases, a history of a previous attack was obtained in 312 (67.8 per cent.).

Of the **exciting causes of appendicitis**, from the clinical point of view, *disturbances of digestion* are the most important. Such is the preeminence of these in the etiology of appendicitis, and with such constancy have they been observed, that it is unhesitatingly asserted that appropriate inquiry will elicit a history of such disturbances in almost all cases. The alterations induced by or causing the acute indigestion may spread to the appendix, and, causing swelling of the mucous membrane, may prevent drainage and lead to appendicitis. On the other hand, it is most likely that the diarrhea that accompanies such attacks results in the conveyance to the appendix, from the upper portion of the intestinal tract, of bacteria that are more virulent than those normally situated in the region of the appendix. And, again, in such attacks of diarrhea the bacteria throughout the intestinal tract increase in virulence. Bacteria of great virulence are, of course, able to engender morbid processes in the appendix more readily than are less malignant bacteria.

That *exposure to inclement weather* and to other deleterious influences acts as an exciting cause of appendicitis can not be doubted. The connection between the exposure and the development of the appendicitis is most clear and direct, and must be accepted as clinically important. The same is also true of *traumatism* in a limited number of cases. Appendicitis has been known to follow traumatism in the region of the appendix with such frequency that its etiologic significance can not be ignored. In those cases in which it is found operative it probably meets with an appendix predisposed to, if not already the seat of, inflammation.

Of other diseases that act as exciting causes of appendicitis may be mentioned typhoid fever, dysentery, tuberculosis, actinomycosis, etc. The ordinary lesions of the appendix in *typhoid fever* have already received attention. The ulceration may progress, and may lead, with or without perforation, to appendicular peritonitis and, as a consequence, to the ordinary manifestations of appendicitis with peritonitis. Such are the diagnostic difficulties presented by these cases that the question of the presence of typhoid fever or appendicitis, or of one as a complication of the other, sometimes can not be decided without recourse to operative procedures.

Dysentery rarely leads directly to the development of acute appendicitis, but the possibility of its occurrence should be borne in mind. The relation of *tuberculosis* and *actinomycosis* to the development of appendicitis will be discussed in the section on the pathology.

PATHOLOGY.

In discussing the pathology of inflammation of the vermiform appendix—appendicitis, scolecoiditis—it seems appropriate, in the first place, to describe accurately the lesions detected upon the examination of a large number of diseased appendices; and, secondly, from a study of these, to deduce conclusions relative to their pathogenesis. This latter may be best accomplished by instituting a comparison between diseased and presumably normal appendices, and by bearing in mind not alone the factors ordinarily provocative of inflammation in other portions of the body, but also certain anatomic and physiologic peculiarities that pertain to the appendix itself. A just conception of the nature of appendicitis, as of other diseases, is, of course, not possible from a study of the pathologic characteristics of its terminal stages alone; to be reliably informed of its pathogenesis special attention must be directed also to the alterations that occur in the very inception of the disease. It is to the infrequency of death in the early stages of appendicitis, to its nonoccurrence in mild cases, and the consequent lack of opportunity for the study of the early and mild pathologic conditions, that the older and erroneous views with regard to the affection then recognized as typhlitis, perityphlitis, etc., may be attributed. It is only at a comparatively recent date that the true nature of inflammations of the right iliac fossa has been determined, and this largely through the investigation of diseased appendices removed by early operation. The lesions herein described and the opinions formulated are founded primarily upon a systematic and detailed examination of 577 appendices removed by operation by Dr.

John B. Deaver, at the German Hospital, from January 1, 1897, to June 30, 1899. In addition, a more or less cursory examination was accorded a considerable number of appendices that had been removed prior to January 1, 1897; various necropsies have been performed upon subjects dead of appendicitis and its complications; and about fifty presumably normal appendices, removed at necropsy from subjects dead of affections other than disease of the appendix, have been investigated. While the following, therefore, is largely a recital of personal views, the observations of other investigators have not been ignored.*

In conformity with clinical observation, pathologically two varieties of inflammation of the vermiform appendix may be recognized—an acute and a chronic appendicitis. Like inflammation elsewhere in the body, the inflammatory manifestations in the appendix may commence either acutely or chronically.

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* The routine examination to which, in general, each appendix was subjected consisted in carefully photographing it; weighing it; measuring its length, its exterior diameter, the thickness of its wall, and the diameter of its lumen throughout its extent; noting its macroscopic appearances; hardening and embedding it, and cutting and staining sections from at least three regions of each appendix and studying their microscopic appearances; and bacteriologic investigations of the contents of the lumen of the appendix, of the exudate upon its peritoneal surface, of pus from abscesses, of free pus in the peritoneal cavity, and of drainage-fluid subsequent to the operation. Specifically, the number of appendices photographed was over 350; the number weighed was 532; the length was measured of 532, the exterior diameter of 544, the thickness of the wall of 320, the diameter of the lumen of 320; the macroscopic appearances of 577 were noted; the number embedded, and of which microscopic sections were cut, stained, and studied, was 556; the number examined bacteriologically was 286. It has been deemed inadvisable to overburden this chapter with a mass of statistics that refer to the weight, length, etc., of the appendices examined, as these add practically nothing to our knowledge of the pathology of inflammation of the organ. Mention is made, however, of features of especial interest that were met with.

My thanks are due to M. I. Wilbert, Ph.G., director of the Laboratory of Photography and Radiography and chief apothecary of the German Hospital, for all the photographic work and for a considerable proportion of the measurements of the appendices, and to Drs. C. W. Wille, J. F. Sinclair, U. J. W. Peters, J. W. Curry, E. K. Moore, and A. A. Uhle, resident physicians of the German Hospital, for the preparation of microscopic specimens.

If, in a given instance, the former be the case, the acute manifestations may subside after a greater or less interval of time, and the pathologic alterations may persist as a chronic inflammation. Chronic inflammation may thus be the residual manifestations of a previous acute inflammation, or the condition may be inaugurated as a chronic inflammation. Of the acute and chronic forms of appendicitis, several varieties may be distinguished, and for purposes of pathologic study it is deemed advisable to adopt some rational classification. The following classification, based upon the results of this investigation, but which does not differ essentially from several that have already been proposed, is suggested:

Acute Appendicitis:

1. Catarrhal.
    (*a*) Simple.
    (*b*) Purulent.
    (*c*) Hemorrhagic.
2. Interstitial.
3. Ulcerative.
    (*a*) Nonperforative.
    (*b*) Perforative.
4. Gangrenous.

Chronic Appendicitis:

1. Catarrhal.
2. Interstitial.
3. Obliterating.

This classification, which is pathologically well founded, as it indicates the nature of the lesions of the appendix, is not in contravention of the clinical course of the disease. It must, however, be candidly admitted that we are not always able to distinguish clinically the different pathologic varieties of appendicitis. In other words, the different pathologic varieties of the affection may present analogous clinical manifestations. Again, the severity of the clinical manifestations of an individual attack of appendicitis frequently bears no proportion to the seriousness of the lesions of the appendix, nor is the number of attacks always a reliable index of the condition of the appendix. And, further, it may be stated that not uncommonly the different varieties of both acute and chronic appendicitis are but stages of a single pathologic process. An inflammation of the appendix, originating as a catarrh, may, in a given instance, progress to the interstitial variety. This in turn may be succeeded by ulceration which, depending upon a variety of circumstances, may or may not lead to perforation of the organ. Gangrenous appendicitis may also make up the sequence in such a train of events, though it not infrequently arises in a totally different manner. Similarly, chronic interstitial appendicitis may follow that process which began as a chronic catarrh, and not the least interesting, if not the most common, form of this chronic inflammation of the appendix is the obliterating variety. Again, an appendix that for a longer or shorter period of time has been the seat of chronic inflammation may suddenly suffer an acute exacerbation, and may present the most intense degrees of acute interstitial inflammation, with suppuration, ulceration, or gangrene, and well-marked and fatal peritonitis. On the other hand, a severe attack of appendicitis may be partly recovered from, and may be succeeded by several much milder attacks. Indeed, an acute exacerbation of the lesions of a chronically inflamed appendix is one of the most likely of events. The majority of cases of chronic appendicitis are those in which the appendix has been the seat not alone of a chronic inflammation, but also of recurring attacks of more or less acuteness—cases designated clinically as recurring or relapsing appendicitis. In addition, the inflammatory phenomena in different appendices vary with respect to the situation and extent of the lesions and the rapidity of their progress, and these are not uninfluenced by the possibly persisting consequences of previous inflammation. Furthermore, the most diverse peritoneal lesions may be associated with different cases of the same variety of appendicitis. None of these facts, however, constitutes a valid reason against the adoption of a rational pathologic classification. Rather do they indicate the similarity in the reaction of the body to diverse morbid conditions, and the limitations of our diagnostic ability

The foregoing classification, based, as it is, upon the nature and character of the lesions occurring in the several varieties of appendicitis, seems more appropriate than those which comprise such terms as "simple," "mild," "perforating," "infective," etc. "Simple" and "mild" refer merely to the severity of the clinical manifestations, and, as already stated, this is often no index to the seriousness of the lesions of the appendix. "Perforative" merely indicates an accident that may or may not happen in the course of ulcerative and gangrenous appendicitis. The reservation of the term "infective" to designate certain cases only of appendicitis is inappropriate; for, as will be seen later, the vast majority of all cases of appendicitis must be attributed to the pathogenic activities of bacteria. An etiologic classification based upon the variety of the offending micro-organisms is as yet impossible.

Of the 577 appendices, removed by operation, that were investigated, 21 were not examined microscopically and 9 were removed from persons who presented no clinical symptoms of appendicitis, but who were operated upon for some other condition, the appendix being removed at the same time. Of the remaining 547, there were 239 instances of acute appendicitis, 305 of chronic appendicitis, 2 were instances of primary carcinoma and 1 of endothelioma of the appendix.* The last-mentioned presented, in addition to the endothelioma, mild interstitial inflammatory alterations; and the other two cases of tumor of the appendix, in addition to the carcinoma, showed intense interstitial inflammation with ulceration. Of the 239 acute cases, 9 were of the catarrhal variety, 38 of the interstitial, 142 of the ulcerative (68 nonperforative, 74 perforative), and 50 of the gangrenous variety. Of the 305 chronic cases, 6 were of the catarrhal variety and 299 of the interstitial variety—6 of the latter being of the obliterating subvariety. Many of the chronically inflamed appendices presented, in addition, evidences of more or less acute exacerbation.

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* Since the foregoing [illegible] of carcinoma of the appendix has been e[illegible] f four malignant tumors of the [illegible] endices removed by operation

The pathology of inflammation of the vermiform appendix will be discussed as follows:

1. *The lesions of the appendix.*
2. *The peritonitis and its consequences.*
3. *The bacteriology.*
4. *The pathogenesis.*

THE LESIONS OF THE APPENDIX.

ACUTE APPENDICITIS.

ACUTE CATARRHAL APPENDICITIS.

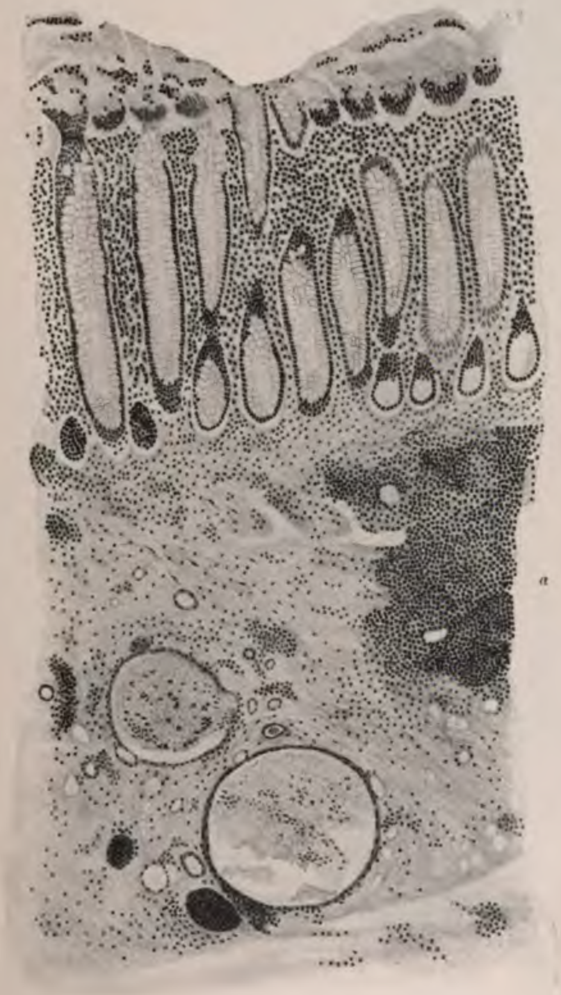
By acute catarrhal appendicitis is understood that variety of acute inflammation of the appendix in which the pathologic alterations are wholly or almost wholly confined to the mucous membrane, the other coats of the organ presenting but little or no deviation from the normal. In this connection the term catarrhal is employed strictly within its pathologic significance. Implying, as it does, a superficial inflammation limited to the mucous membrane, it is certainly incorrect to apply it, as has been done, to inflammatory conditions of the appendix in which the lesions involve the deeper layers of the wall of the organ.

That this variety of appendicitis does occur there can be no question. It is not true, as has been held by Talamon and others, that in every case of inflammation of the appendix all the coats are involved, or that, at least, the inflammatory alterations extend to and implicate the muscular coats. Nor can I agree with Kelynack, who considers the term catarrhal most open to objection because of its suggesting a superficial inflammation—he thereby implying that such a condition does not occur in the appendix. Acute catarrhal appendicitis is probably not uncommon. It doubtless often gives rise to but few clinical manifestations, and, most likely, under some circumstances to none at all, as, for instance, if the lumen of the organ be of good caliber. This opinion is borne out by the many instances of catarrhal inflammation of the appendix disclosed by systematic examination of a large number of appendices removed postmortem from those who during life presented no clinical manifestations of such disease. In many of these cases the lesions are strictly confined to the mucous membrane. That this variety of appendicitis, however, is infrequently met with at operation is indicated by the fact that of the 239 cases of acute appendicitis that were investigated, but 9 were of the catarrhal variety. It is quite likely, nevertheless, that if many of the appendices which when deranged give rise to very mild clinical symptoms—amenable in the early attacks, at least, to medicinal treatment—were examined microscopically, they would reveal evidences of catarrhal inflammation. It is likely, also, that this variety of appendicitis inaugurates many of the more severe varieties of acute inflammation, and it is doubtless commonly the starting-point of many of the chronic cases.

Macroscopy.—In this variety of appendicitis, to the naked eye the general configuration and external appearances of the organ are not appreciably altered, although it may feel a little stiffer or firmer to the touch. The mucous membrane is swollen, hyperemic, and edematous. The lumen of the organ may be partly or completely occluded at one point or at several places, and this is the more likely to be the case, the narrower the lumen prior to the attack of inflammation and the more intense the latter. The mucous membrane is covered with a secretion that partly or completely fills the lumen of the organ if it be pervious. This secretion is variable in amount and character. It may be abundant or meager, depending to a considerable extent upon the intensity of the inflammation. In character it may be clear and mucous, turbid, grayish or yellowish-green, or brownish and purulent; or sanguinolent; or a combination of any of these. The contents of the appendix vary, depending upon whether they consist solely of such secretion, or of the latter combined with more or less fecal matter. They may be fluid or semi-fluid, or may approach the consistency of inspissated fecal matter. In this variety of appendicitis I have not encountered any true appen-

ACUTE CATARRHAL APPENDICITIS.—The section shows the mucous and submucous coats of the appendix. The crypts of Lieberkühn are much distended and their lining epithelial cells, as well as those lining the lumen of the organ, are occupied by clear droplets of mucin that displace the nuclei toward the bases of the cells. In addition, there is serous and a small amount of cellular infiltration of the mucosa. At *a* there is a rather large lymphoid nodule. In the lowermost portion of the submucosa there are two blood vessels that are distended with blood, and about which there is a slight amount of round-cell infiltration. Hematoxylin-eosin preparation. × 250.

PLATE VI



dicular calculi. The odor of the contents is also variable. It is commonly distinctly fecal in character, with different degrees of malodorousness. Occasionally the lymphoid follicles appear enlarged. The crypts of Lieberkühn can usually be detected distinctly distended, commonly with a grayish or a grayish-yellow secretion. If the inflammation be rather intense, the secretion is likely to be distinctly purulent; hence the designation, *purulent catarrhal appendicitis.* Under such circumstances slight superficial erosion and desquamation of the epithelium of the mucous membrane may supervene, and if the inflammation be still more intense, rupture of minute vessels in the lowermost layers of the mucosa may occur. The hemorrhagic foci that thus ensue justify the designation *hemorrhagic catarrhal appendicitis.* These various lesions may extend uniformly throughout the length of the appendix, or they may be relatively intense in one portion and comparatively inconspicuous in others. Indeed, certain regions may be entirely unaffected.

Microscopy.—Upon microscopic examination of such appendices (Plate VI) the crypts of Lieberkühn are found distended to a variable degree. The contents are usually of the well-known mucous nature; occasionally, however, they are muco-purulent, purulent, or hemorrhagic. The individual epithelial cells of these crypts, as well as those of the surface epithelium, are swollen, distorted, and occupied by a clear, translucent, spheroid, or ovoid droplet which, situated toward the free extremity of the cell, displaces the cell protoplasm and the nucleus downward or somewhat to one side. This droplet reveals the characteristics of mucin generally, and is commonly elaborated without destruction of the cell body. After the discharge of this droplet the cells reveal the characteristic goblet appearance, and subsequently they may assume their normal configuration and appearance. Some emigrated leukocytes are usually visible between the epithelial cells, and the entire mucosa is the seat of more or less serous infiltration. Besides these alterations and some congestion of the vessels of the mucosa and submucosa the mild forms of this variety of inflammation of the appendix may present no noteworthy pathologic features. If, however, the inflammation be more intense, in addition to the foregoing changes there are noticeable a more marked congestion of the vessels of the mucosa and submucosa, a greater degree of serous infiltration, a more marked infiltration of the retiform tissue of the mucous membrane with emigrated leukocytes, some cellular proliferation, and desquamation of the epithelial cells of the crypts of Lieberkühn and of those lining the lumen of the appendix. In some of the severer cases the cellular exudate becomes more excessive, and gives rise to marked swelling of the mucous membrane and to pressure upon the crypts of Lieberkühn. Partly because of this, and also because of the desquamation of their epithelial lining, some of these crypts become obliterated. Under such circumstances the cellular exudate reaches the surface of the lumen, and being cast off, commingled with desquamated epithelial cells, excessive mucus, and granular debris, constitutes the microscopic evidence of *purulent catarrhal appendicitis.* The contents of the lumen are composed of similar matter. The desquamation of the epithelial cells may occur slowly or rapidly, and the cells desquamated may either be in a good state of preservation or they may be already partly or completely necrotic, or the seat of serous or mucous infiltration. If the inflammation be still more intense, the alterations already described become more marked, and there may occur some diapedesis of erythrocytes from the vessels. Indeed, in a small number of cases minute hemorrhagic foci may be detected—*hemorrhagic catarrhal appendicitis.* In all cases of catarrhal appendicitis, excluding possibly the very mildest forms, there is some swelling, congestion, and serous infiltration of the lymph nodules.

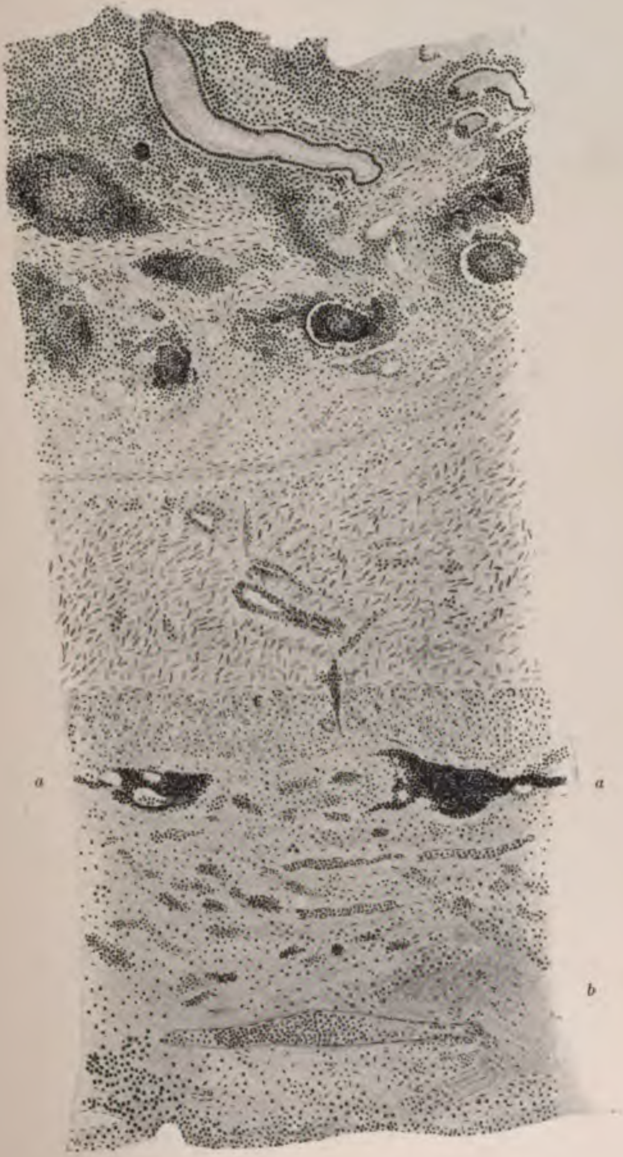
The further course of such catarrhal appendicitis is one of three: In a very few instances it is possible that, if the lesions be very slight, a complete restoration of the mucous membrane to its former condition may take place. The contents of the appendix are discharged into the cecum, the congestion and swelling of the mucous membrane subside, the leukocytic infiltration and the cellular exudate are absorbed, and desquamated and eroded epithelial cells are replaced by newly formed cells. The likelihood of such *restitutio ad integrum* is influenced by the cause of the inflammation, the free and thorough drainage of the organ, and the character and virulence of the micro-organisms present. Analogy and some facts warrant us in supposing that such mild catarrhal appendicitis is more common than is generally thought, that clinical manifestations are often slight or entirely absent, and that in some such instances the appendices return to their previously normal condition. In the majority of cases, however, in which the lesions are sufficiently intense to give rise to clinical manifestations, and in all cases in which the previously detailed pathologic alterations are at all marked, the return of the appendix to its normal condition is not possible. The acute manifestations either partly subside and become chronic, or they become more intense, more generalized, and lead to some of the severer forms of appendicitis. This latter is a very likely event, not alone because of the natural tendency of the disease, but also because of the liberal lymphatic supply of the appendix, whereby the noxious agents provocative of the lesions of the mucous membrane readily gain access to and implicate the deeper layers of the wall of the organ.

ACUTE INTERSTITIAL APPENDICITIS.

By acute interstitial appendicitis is understood that variety of acute inflammation of the appendix in which the pathologic alterations extend throughout and involve all the coats of the organ. An inflammation of the appendix may implicate all the coats of the organ from the outset, but, as already stated, it is not unlikely that catarrhal alterations inaugurate the process in a considerable number of cases. The extensive lymphatic supply of the organ furnishes a ready means for the rapid dispersion of the agents causing the inflammation, thus engendering the generalization of the process. That this form of appendicitis is more common than the catarrhal variety, or at least gives rise to clinical manifestations more frequently, is indicated by the fact that of the 239 cases of acute appendicitis examined, 38 were of the interstitial variety. In this form the pathologic alterations are commonly more intense in

ACUTE INTERSTITIAL APPENDICITIS.—The section is through the entire wall of the appendix. There is some erosion of the mucous membrane and loss of the surface epithelium. The mucous glands are distended and their epithelial cells are occupied by clear droplets of mucin that displace their nuclei toward the bases of the cells. In addition to serous and cellular infiltration, which are most marked at the surface, the mucous membrane presents several lymphoid nodules. In the submucous and muscular coats the blood vessels are much dilated, and there is a varying amount of round-cell infiltration. At *a* there are several large collections of round cells, most of which are polynuclear, constituting interstitial abscesses. At *b* there is an area of hemorrhagic infiltration. Hematoxylin-eosin preparation. × 250.

PLATE VII



one coat than in others, and they vary also in different regions of the same coat.

Macroscopy.—To the naked eye the appendix appears swollen, edematous, and reddened; and injection of many of the vessels beneath the peritoneal covering can commonly be distinctly detected. If the inflammation be of minor grade, the organ is quite firm to the touch; but if it be either moderate or intense, the appendix often seems softer than normal. The mucous membrane is swollen, hyperemic, edematous, and softened, and the entire wall of the organ appears thicker than normal. The mucous membrane is more likely to reveal minute hemorrhages than in catarrhal appendicitis. Occlusion of the lumen in one or more places is common. If it be patulous, the contents are muco-purulent, purulent, or hemorrhagic; and they are more likely to be the last named, and also to be very malodorous, in this than in the catarrhal variety. The other macroscopic appearances do not differ materially from those described in connection with the catarrhal variety, though the swelling of the lymphoid follicles is more likely to be conspicuous. Appendicular calculi were found in two (6.2 per cent.) of 32 of the appendices examined.

Microscopy.—Upon microscopic examination (Plate VII) the pathologic alterations described in connection with the microscopy of catarrhal appendicitis are evident. They are, however, commonly more marked in degree. The crypts of Lieberkühn are often almost completely obliterated, there is dense cellular infiltration of the retiform tissue of the mucous membrane, and the latter is not infrequently represented by a dense aggregation of small round cells that extend to the free edge, and in which remnants of degenerated epithelial cells and crypts of Lieberkühn are discernible. In addition, the pathologic alterations have extended to, and more or less extensively involve, the submucous, muscular, and subserous coats. Throughout the submucous and muscular coats there are a variable amount of dilatation of the blood vessels, some serous infiltration, and a more or less dense collection of small round cells. At times these small round cells infiltrate more or less diffusely one or all of the layers of the wall of the appendix, causing separation of the fibrillar and muscular bundles and constituting a veritable *purulent* or *phlegmonous infiltration* or *suppuration of the appendix*. On the other hand, these small round cells may be congregated into smaller or larger masses, forming circumscribed abscesses—*interstitial abscesses*—in various regions of the organ. While the diffuse infiltration is more likely to predominate in the muscular layers, the small, circumscribed abscesses show a predilection for the submucous and subserous layers. No definite rules, however, can be laid down for these. The leukocytic infiltration is especially conspicuous about the blood vessels, but evidences of productive inflammatory alterations are common elsewhere. In cases of moderate and more intense inflammation hemorrhagic foci are relatively common. At times these are small; at times, however, they are very extensive, and give rise to more or less wide-spread destruction of tissue.

A conspicuous feature of this, as well as of the more severe varieties of appendicitis, is the involvement of the lymphoid elements. These are commonly swollen and are generally the seat of serous infiltration. The capillaries and lymph spaces appear distended,—the former filled with blood corpuscles, the latter with lymph corpuscles, leukocytes, and sometimes erythrocytes,—and into their lumens there project proliferating endothelial cells. At times the latter desquamate, and thus assist in occluding the distended spaces. There also occurs an infiltration of the nodules with leukocytes and an active proliferation of the cells of the reticulum. In the immediate vicinity of these lymphoid follicles there are often small collections of lymphoid cells; these should not be confounded with the results of productive inflammation, which also abound. In the more advanced stages of the inflammation these lymphoid follicles undergo various retrograde changes. They commonly become necrotic, the necrosis arising in one of two ways: it may commence in or about the center of the follicle, and more or less rapidly involve the entire nodule; or small scattered foci of necrosis may simultaneously, or almost simultaneously, arise in different portions of the follicle, and, finally, either become confluent or remain discrete. It has seemed to me that the latter form of necrosis is the more common. At first the nuclei of the lymphoid cells, and later those of the reticulum, refuse to stain well. They appear indistinct and blurred, and their edges become ragged. Subsequently, hyperchromatosis, chromatolysis, or karyorrhexis supervenes, and plasmolysis follows or occurs coincidentally. Finally, the focus undergoes complete liquefaction. Neighboring areas become similarly affected, and several adjoining foci may become confluent and form larger ones. The exudated polynuclear leukocytes participate in the process and speedily become liquefied. The reticulum, sometimes at first homogeneous, later becomes granular and liquefies. There thus develops within the wall of the appendix, without of necessity any solution of the continuity of the mucous membrane or of the serous coat developing, a focus, or several foci, of softening which, in the later stages at least, consist largely of purulent matter—*follicular abscess.* This commonly ruptures into the lumen of the appendix, and there is thus produced a form of ulcerative appendicitis, of which mention will be made subsequently. Hemorrhage sometimes occurs into these foci of softening, and around them, at times, various deposits of blood pigment are discernible.

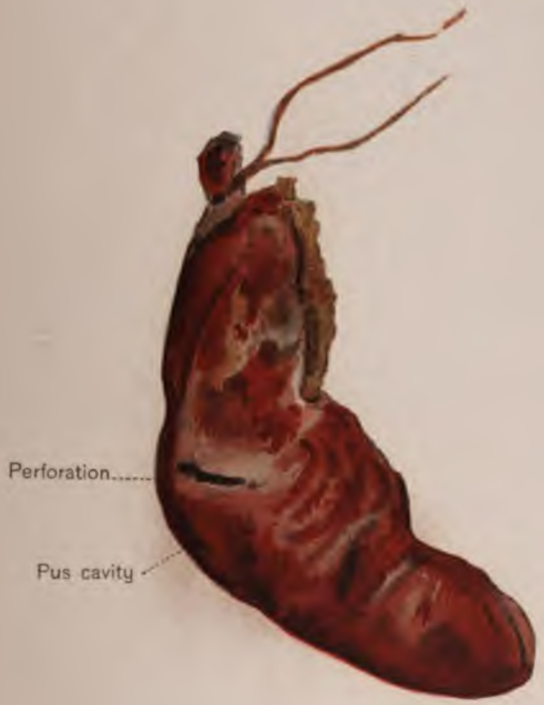
The pathologic anatomy of this, as well as of the ulcerative, form of appendicitis varies somewhat, depending upon the possibly persisting consequences of previous inflammation. At times, as a result of previous acute or chronic inflammation, there may have formed strictures, angulations, or flexures which obstruct the lumen of the organ. Under such circumstances the appendix may be divided into two or more compartments, and each of these may present pathologic alterations different from the others. One portion may reveal only catarrhal inflammation; another, in addition to this, rather marked interstitial inflammation; while, under some circumstances, another portion may be practically unaffected. The proximal portion is the most likely to present no deviations from the normal. The tip, on the other hand, is not infrequently seriously involved, being distended and filled with clear or turbid fluid or with pus. The contents of the dis-

ACUTE ULCERATIVE APPENDICITIS (EMPYEMA OF THE APPENDIX) WITH PERFORATION.—M. T., aged twenty-one years, a theologic student, was admitted to the German Hospital, December 11, 1895, with a history that one week prior to admission he had been suddenly seized with violent, cramp-like pains in the abdomen, severe vomiting, and fever, his temperature being 102° F. Examination revealed marked tenderness in the right iliac region, rigidity, and distention. One year prior to admission he had had a similar attack, and another in June, 1895.

The operation, performed December 12, 1895, revealed the appendix markedly swollen and distended with a considerable quantity of malodorous pus. It was the size of an adult finger, very friable, covered with plastic exudate, embedded in an abscess wall, and perforated near its middle. An appendicular calculus was found in the abscess cavity. Gauze drainage was employed.

The patient made a good recovery.

PLATE VIII



Acute ulcerative appendicitis—empyema of the appendix—with perforation.

tended portion may be purulent from the commencement of the inflammation, or there may occur a purulent metamorphosis of previously clear fluid. This condition, in which the lumen of the appendix has been converted into a closed cavity and is filled with pus, is spoken of as *empyema of the appendix.* (Plates VIII and IX.) Under these circumstances the wall of the appendix constitutes the wall of the empyema or abscess cavity. The development of an empyema of the appendix presupposes a stenosis or complete occlusion of the lumen, and this may be brought about by twists or angulations of the organ, internal cicatrices resulting from previous inflammation, or external cicatrizing bands of adhesions. The stenosis or occlusion of the lumen may occur at any point along the appendix, and in consequence the empyema may involve the entire organ or only part of it. We thus speak of a partial or complete empyema, as the case may be. The empyema may develop slowly or rapidly, and it may be rather small or may attain a considerable size. It commonly occurs in connection with acute inflammation, but that it also develops in association with some cases of chronic inflammation (a few of them possibly tuberculous), and with acute exacerbations of chronic inflammations, is well established. Although in its initial stages this condition of empyema may be present without appreciable ulceration of the appendix,—that is, it may be associated with catarrhal and interstitial appendicitis, with intact basement membrane,—from its very nature it forms a transition stage to ulceration of the appendix, and is commonly found in connection therewith. If such an appendix be not removed by operation, there occur serous and cellular infiltration and necrosis of the wall of the organ, excessive distention, perforation, and peritonitis. The final process is similar to ulcerative appendicitis.

It is not possible for the interstitial variety of appendicitis to eventuate in the restoration of the organ to its previous healthy condition. If the pathologic alterations are slight or moderate in degree, and if there are productive connective tissue changes rather than polynuclear leukocytic infiltration, the acute manifestations may subside and a variety of chronic appendicitis

Chronic Interstitial Appendicitis—Empyema of the Appendix.—H. C. D., a physician, has presented the following report:

On July 20, 1894, I was awakened by a feeling of discomfort in the abdomen, located chiefly around the umbilical region. It gradually grew worse until I had severe pain in this region. I took ¼ of a grain of morphin, which gave me relief. I was able to get up and attend to my work two hours afterward. There was some soreness, discomfort, and tenderness on deep pressure over the region of the appendix. In four or five days I was feeling much better.

I remained apparently well until September 20th, when I had a similar attack, which was more severe, and confined me to bed for six hours; vomited freely, principally bilious matter. After being purged freely by citrate of magnesium I was relieved, but the soreness over the appendix remained for one week.

For three months I had perfect health and gained in flesh. On December 30th I had another attack, accompanied by severe pain and distress in the abdomen; vomited freely without relief. Stomach was irritable for thirty-six hours after this ceased. I took a dose of castor oil, which acted in four hours. After the first bowel movement I felt greatly relieved. Temperature ranged from 99° to 101½° F. The attack was due to cold. After this attack I was not well. Had more or less soreness over the appendix, attended by obstinate constipation and dyspeptic symptoms. At times I had a great deal of pain in the right testicle.

At operation, performed March 26, 1896, the appendix was found markedly distended. Upon incising it, there were found two cavities containing pus, and separated from each other by an area of constriction. The distal third of the lumen was entirely obliterated and the remainder of the wall was greatly thickened.

Recovery was uneventful.

Fig. I

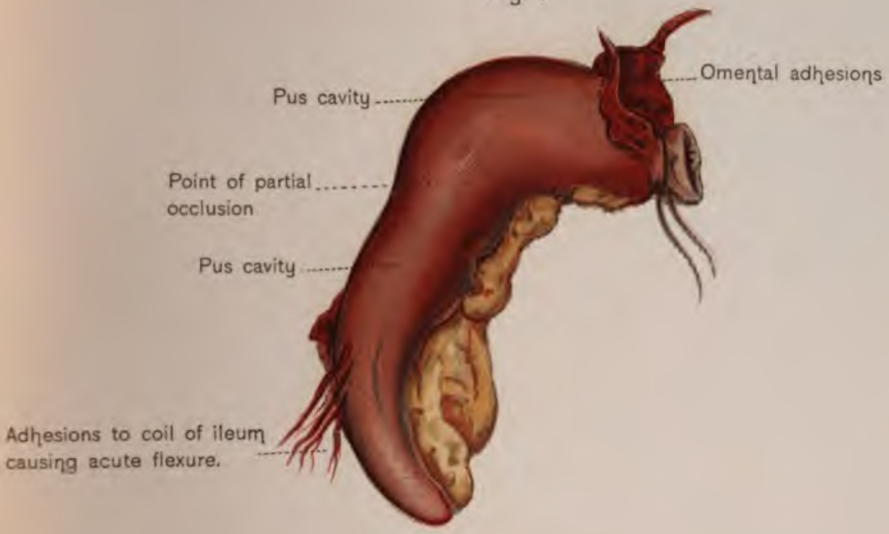
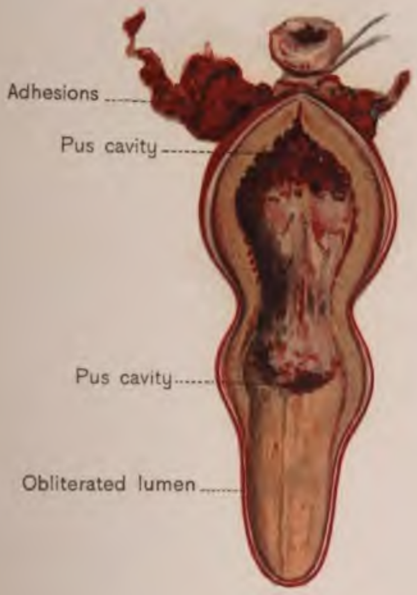

Pus cavity
Omental adhesions
Point of partial occlusion
Pus cavity
Adhesions to coil of ileum causing acute flexure.

Fig. 2



Chronic interstitial appendicitis—empyema of the appendix

FIG. I. External aspect of the appendix illustrating the excessive and irregular distention of the organ.

FIG. 2. Internal aspect of the appendix illustrating two pus-cavities with an intervening area of constriction of the lumen, and entire obliteration of the distal third of the lumen.

may result. It is much more likely, however, if the appendix is not excised or the patient does not die, that the pathologic changes will progress to necrosis and ulceration.

ACUTE ULCERATIVE APPENDICITIS.

By acute ulcerative appendicitis is understood that variety of acute inflammation of the appendix in which there occurs a liquefaction necrosis of the inflammatory exudate and of more or less of the wall of the organ in communication with its lumen. This is naturally but an aggravation of the previously described forms of appendicitis, and both the catarrhal and interstitial varieties may present gradual progression to it. It is possible, however, for ulcerative appendicitis to arise without previous catarrh; it may be due to septic infection, typhoid fever, dysentery, etc. Two forms may be distinguished—a nonperforative and a perforative. One is but an aggravation of the other—perforation being an accident that may or may not occur in the course of the affection. That this variety of appendicitis is relatively common is indicated by the fact that of the 239 cases of acute appendicitis examined, 142 were of the ulcerative variety—68 being nonperforative and 74 perforative.

Macroscopy.—To the unaided eye (Plate x) the appendix is swollen, edematous, excessively congested, and may seem a little firmer to the touch than normal, in consequence of the tension of the peritoneal covering. In the event, however, of perforation, or of perforation being imminent, the area of such impending or actual perforation can readily be distinguished by its being softer than the surrounding tissue. The swelling and edema vary in different portions. Usually, they are very irregularly distributed, being more marked in one region than in another. In places the seat of serious disease the appendix may be as thick as a finger or thicker, whereas other portions may be not thicker than a lead-pencil and almost normal in appearance. Certain regions may present merely dilatation of the blood vessels, the larger ones being distinctly distended, while those ordinarily invisible to the unaided eye are readily

ACUTE ULCERATIVE APPENDICITIS.—Miss B., aged twenty years, was admitted to the German Hospital, November 16, 1895, with a typical attack of acute appendicitis. At operation, which was performed immediately, it was found that the appendix and meso-appendix were highly inflamed, and the appendix was thickened and firm to the touch, from the tenseness of the serous covering. Upon incising the appendix the contents were found to be mucopurulent and of a disagreeable fecal odor. The mucous membrane was roughened, of variegated color, and necrotic.

Recovery was rapid and uninterrupted.

Fig. 1

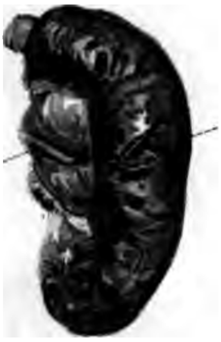
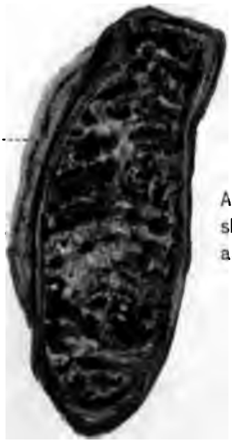


Fig. 2



Acute ulcerative appendicitis

FIG. 1. External aspect of the appendix illustrating the increase in the size, the diffuse redness, and the marked engorgement of the blood-vessels of the organ.

FIG. 2. Internal aspect of the appendix illustrating the muco-purulent contents and the *ulceration and* necrosis of the lining membrane.

perceptible. In other portions there may be a diffuse redness, varying in shade from an intense bright redness to a deep reddish-blue or purplish color. If perforation be imminent, the area involved is usually of a brownish-green or blackish-green color, and is softer and more prominent than the adjoining region. It is closely surrounded by an area of intense bright redness, and is usually covered by some discolored exudate. There may be only one of these spots of impending perforation or there may be several of them, and they may be situated anywhere along the course of the appendix. Such spots are most frequently found opposite the attachment of the meso-appendix. Not uncommonly, however, they are near the attachment of the meso-appendix, and sometimes they are encountered between the two layers of this structure. Several of these may apparently coalesce to form larger areas. Under such circumstances perforation of the wall of the appendix is most likely to ensue. The perforation may be exceedingly small—scarcely perceptible; or it may be large enough to admit a straw or a goose-quill; or, exceptionally, it may be upward of a centimeter in extent. Perforations more than a centimeter in size are very uncommon, unless as a result of circular amputation or of wide-spread gangrene of the organ. There may be only one perforation or there may be several, varying in size and situation. They may be close together or quite removed from one another. Although, as a rule, the perforation occurs in the center of the previously mentioned spot of discoloration, such spots may individually reveal several perforations. The perforation is usually round, but it may be ovoid, elongated, or without definite outline. If irregular, it may course in the direction of the long or transverse axis of the organ or diagonally. The edges are usually very ragged.

Perforation of the appendix is considered to have occurred when communication has been established between the exterior of the organ and its lumen. In contradistinction to this, it not infrequently happens that a circumscribed abscess in the wall of the appendix ruptures externally—that is, through the serous coat—without a communication being established with the lumen. In the event of true perforation, conditions are favorable for the escape of fecal matter from the lumen of the appendix into the peritoneal cavity; in the other variety of perforation, or rupture of a portion of the wall, such an accident can not occur.

The contents of the lumen in ulcerative appendicitis vary but slightly; they may be muco-purulent, though they are commonly distinctly purulent, with more or less admixture of fecal matter, and very malodorous. (Plate x.) On the other hand, if perforation have occurred, the lumen may be practically empty. The wall of the appendix is thickened, especially at the seat of most manifest disease. On the inner aspect there are seen marked alterations of the lining membrane and a variable number of ulcers. That portion of the mucous membrane that is not ulcerated is much swollen, congested, softened, and commonly presents minute hemorrhagic foci. Often, however, the entire mucous membrane is yellowish-green, much discolored, and resembles a false membrane. At times there is a single ulcer; at times several, that vary in size and situation. The ulcers may be situated anywhere along the length or circumference of the organ. They usually correspond in location to the areas of discoloration visible on the external aspect, though some ulcers, particularly if they be superficial, may reveal no external indications of their presence. They are rather common opposite the attachment of the meso-appendix, probably because in this situation the blood supply is poorest. These ulcers may be round, ovoid, elongated, or irregular in outline. They may involve one, two, three, or all of the coats of the appendix. They usually have sloping edges, in that the greatest destruction of tissue is at the surface—the mucous membrane. At times, however, and not infrequently in the early stages, excessive swelling and edema of the tissues obscures or completely effaces such characteristic of the ulcer. It is merely a question of the severity of the pathologic lesions, and to some extent also of the duration of the disease, whether the ulcerative condition goes on to perforation or not. Many cases of nonperforative ulcerative appendicitis in which the appendix is excised early would, if operation were deferred, progress to perforation. The surface of the ulcer is usually intensely red. Not uncommonly, however, it is of a greenish-yellow or greenish-black color, and is covered with discolored purulent or purulent fecal matter; when this is removed by irrigation, the surface of the ulcer is seen to be the seat of hemorrhagic suffusion. If perforation have occurred, the ragged edges of the opening are also visible. In the neighborhood of the ulceration—or, more particularly, of the perforation, if this has occurred—an appendicular calculus may be detected. Not infrequently this will be found occupying a site directly over the ulceration; often enough, however, just above, and less commonly below, the latter. Exceptionally, it will be found within the perforation, partly or completely occluding it; and in a fair proportion of cases of perforation diligent search will often be rewarded by the discovery of the calculus in the exudate or pus surrounding the appendix.

Although it is generally held that appendicular calculi—otherwise spoken of as as fecal concretions—are common in this variety of appendicitis, statistics differ widely as to the frequency of their occurrence. In 120 of the author's cases they were found in 28 (22.3 per cent.). Of these 120 cases, 56 were nonperforative, and calculi were found in 9 (16 per cent.); 64 were perforative, and calculi were found in 19 (29.8 per cent.). There can hardly be much question, however, that they are more frequently present than these latter figures indicate. The foregoing statistics include only those cases in which the calculus was detected in the appendix when it was examined in the laboratory.

Reference has been made to the fact that in certain cases of ulcerative appendicitis with perforation the calculus may have escaped from the appendix before the time of operation or necropsy; in these cases its presence may be undetected at the subsequent examination. There is thus no doubt that the author's figures do not indicate the exact frequency of calculi in ulcerative appendicitis with perforation. On the other hand, it is believed that more or less inspissated fecal matter has been classed by some surgeons as fecal concretions, and that this fact serves to indicate in their statistics a greater frequency of calculi than is actually the case. Such inspissated fecal matter is quite common, but in the statistical study of this subject has been ignored by the author, only well-formed calculi being considered.

Perforation of the appendix results from the direct necrotic action of bacteria and their toxins, or from the mechanical action of calculi, or from the combined action of both. Exceptionally, it results from the bursting of an empyema, but under such circumstances the rupture is not unconnected with the activities of bacteria. Perforation of the organ is favored by anemia, due to withdrawal of the proper blood supply. This may be the consequence of twists, flexures, or angulations of the organ; of the action of external cicatricial bands of adhesions; of thrombo-arteritis or thrombo-phlebitis; or of a combination of any of these factors. Predominance in causing perforation of the appendix must, however, be accorded bacteria. Calculi, nevertheless, are of considerable significance; but it is not warrantable to state that they must have been operative in all cases, assuming in those cases in which they were not found that they must have been overlooked or must have become disintegrated in the pus or exudate. They are often of decisive importance in determining the *site* of the perforation.

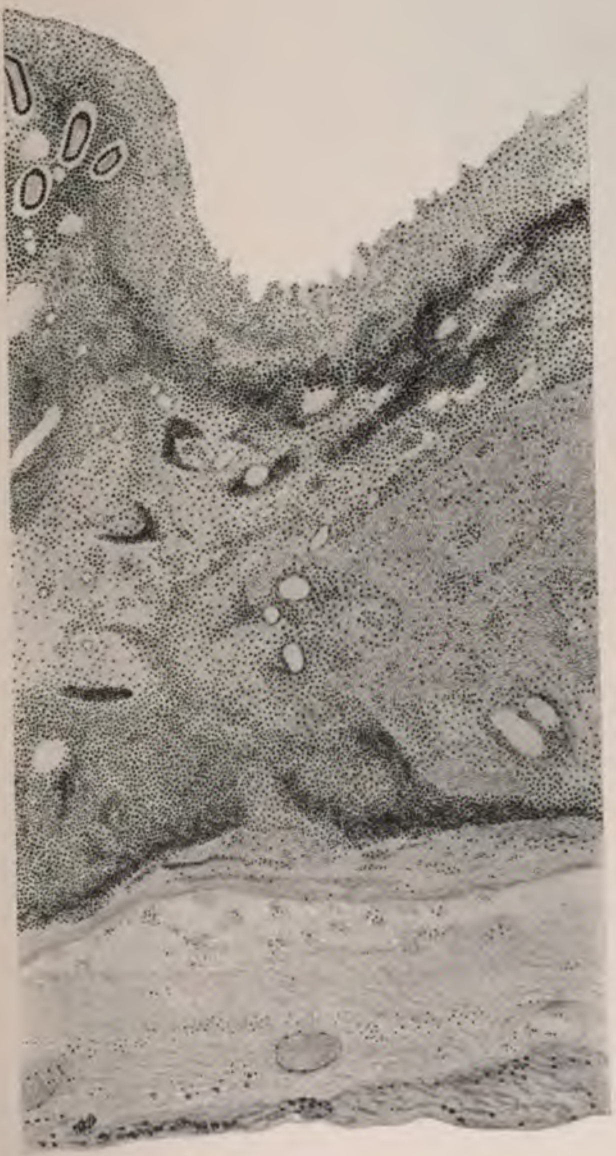
Perforation of the appendix, in the majority of cases, occurs into preformed peritoneal adhesions, and gives rise to a circumscribed peri-appendicular abscess. If, however, the perforation ensue very early in the course of the affection, before the peritoneum has had time to set up reactive adhesions, the contents of the appendix are evacuated into the general peritoneal cavity, and there results a general peritonitis, of which mention will be made subsequently. Again, perforation may occur into the meso-appendix, and the contents of the appendix, liberated and dissecting up the two layers of this structure, may eventually reach the retroperitoneal connective tissue and there produce a retroperitoneal abscess. Under some circumstances the appendix has formed attachments with various organs, and, in the event of perforation of the appendix, the ulcerative process may continue also into these. If the organ in question be hollow, the ulcerative process, invading first the superficial layers of the appendix, finally its serous coat, then the serous coat of the hollow organ (intestine), until ultimately its mucous coat is perforated, produces a *bimucous fistula*. As it is the cecum with which the appendix most frequently forms adhesions, so also is it the cecum that is most frequently perforated in this manner. But cases have been reported in which perforation occurred into the duodenum and other portions of the intestinal tract. In addition, Keen and Bossard report cases in which perforation occurred into the bladder. In Keen's case the appendix became permanently adherent to the bladder, and there resulted a urinary fistula; in Bossard's case a calculus was evacuated from the appendix into the bladder and formed the nucleus of what later became a good-sized vesical calculus.

It must be borne in mind that even deep ulceration and gangrene do not of necessity lead to immediate perforation of the appendix. In many such cases there result first either a more or less circumscribed or generalized peritonitis, with slight or well-marked intoxication, and the patient dies, or the appendix is removed by operative measures before perforation has ensued. Naturally, however, under such circumstances it is but a question of time when perforation occurs.

In all cases of *typhoid fever* in which there occur morbid alterations in the large intestine it is very probable that examination of the appendix would reveal similar changes; and it is likely, also, that in some cases in which the lesions in the large intestine are inconspicuous those of the appendix may be quite marked. Catarrhal alterations are usually well developed, and during the acme of the disease lesions of the lymphoid tissues are prone to be conspicuous. At times these assume such predominance as to give rise to concurrent appendicitis—*typhoid appendicitis*. Rarely, perforation may ensue, and there may result a circumscribed or diffuse peritonitis. The sequels of such typhoid ulcerations—such as strictures, etc.—are often of considerable moment in the subsequent production of an attack of appendicitis.

Microscopy.—In ulcerative appendicitis (Plate XI) the pathologic alterations already detailed in connection with catarrhal

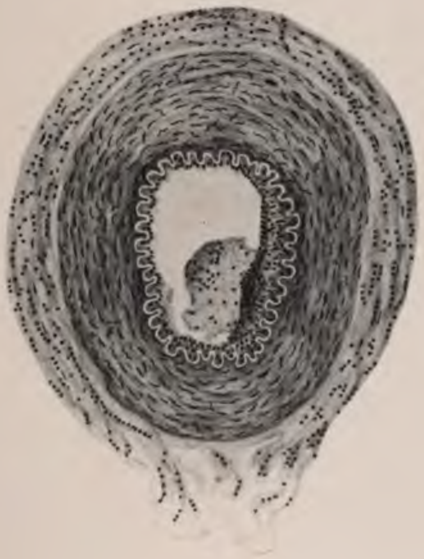
ACUTE ULCERATIVE APPENDICITIS.—The section is through the entire wall of the appendix. To the left there are the remnants of a few mucous glands; to the right, the floor of the ulcer. The entire wall of the appendix presents marked distention of the blood vessels, and serous and cellular infiltration. In the cellular exudate polynuclear leukocytes predominate, and many of them present all gradations of retrograde metamorphosis. The ulceration and necrosis have involved the mucous, the submucous, and a portion of the muscular coats, but such are the alterations that it is impossible to recognize with certainty, in the section, any of the coats of the organ. At *a* there is a very large hemorrhagic focus. At *b* there is a large quantity of fibrinous exudate on the external surface of the appendix. Hematoxylin-eosin preparation. × 250.


a
b

and interstitial appendicitis are present, but in much exaggerated degree. There are excessive dilatation and overfilling of the blood vessels, and marked serous, cellular, and hemorrhagic infiltration of the coats of the appendix. In the cellular exudate polynuclear leukocytes predominate, and many of these present all gradations of retrograde metamorphosis. The necrosis may result in one of two ways: It may commence by erosion and necrosis of the mucous lining of the organ, and, having involved and destroyed the basement membrane of the latter, may successively invade and destroy the subjacent coats, —the submucous, muscular, and subserous tissue,—until finally the peritoneal covering may be implicated, perforation ensuing. Less commonly there develops, as detailed in connection with the interstitial form of appendicitis, an abscess situated beneath the unbroken mucous membrane. It may be situated in the submucous, the muscular, or the subserous coat, and, depending upon its situation, the subsequent events may vary. If it be situated in the submucous coat, as it increases in size it at first encroaches upon, and finally occludes, the lumen. The epithelial cells of the mucous membrane already participating in the inflammation become deprived of their proper nutritive supply, and as a consequence of this, and also of pressure from the abscess, they degenerate. The abscess finally ruptures into the lumen of the organ and an ulcerated surface remains. This ulceration may then progress until all the coats of the appendix are involved, and perforation, as in the aforementioned case, may eventually ensue. This submucous abscess may develop in the submucous connective tissue by liquefaction necrosis of the inflammatory exudate, or it may result from necrosis of one or more of the lymphoid follicles, as previously stated. If, on the other hand, the interstitial abscess be situated near the peritoneal covering, increasing in size, it may finally perforate externally: that is, into surrounding lymph or into the general peritoneal cavity. Under such circumstances, as stated in connection with the macroscopy, there ensues a perforation or rupture of the wall of the appendix without any communication being established between the lumen and the exterior of the organ—there is afforded no

PROLIFERATIVE ENDARTERITIS.—The artery is from an appendix the seat of acute ulcerative appendicitis. The proliferation of the intima to the right is very evident. There is also thickening of the media. In the lumen there is a thrombus attached to the proliferating intima. Hematoxylin-eosin preparation. × 200.

PLATE XII



opportunity for the escape of fecal matter into the peritoneal cavity. The process of ulceration thus inaugurated may progress, and a communication with the lumen may be subsequently established.

The liquefaction necrosis of the inflammatory exudate and of the appendicular tissues may be quite extensive, having developed rapidly, before there is any evidence of it macroscopically. The cell nuclei no longer stain well; they present chromatolysis, karyorrhexis, or hyperchromatosis; the cell protoplasm, plasmolysis; and, finally, the entire area becomes a mass of granular debris. To this fluid is added and the focus disintegrates entirely and is discharged into the lumen of the appendix, leaving usually an extensive ulcer. At times the process of ulceration is not so rapid; the necrotic tissue maintains some connection with the underlying tissues, and much resembles, upon superficial examination, a false membrane. In all cases of ulcerative appendicitis hemorrhagic foci are a conspicuous feature. At times these are quite small —microscopic. Again, they are extensive, evident to the unaided eye, and lead to the utmost destruction of the appendix. Entire layers of the several coats are separated by the infiltrating blood, and excessive disturbance of the topographic relations ensues. At times the blood is found to be in a good state of preservation; again, it is more or less disintegrated, or is represented by blood pigment. Proliferation of the endothelial lining of the blood vessels is evident in a certain proportion of the cases. (Plate XII.)

GANGRENOUS APPENDICITIS.

By gangrenous appendicitis is understood an inflammation or infection of the appendix attended by gangrene. This variety of appendicitis has often been referred to as infectious, under the mistaken apprehension that it, in contradistinction to the other varieties, is due to bacterial infection. The frequency of this variety of appendicitis is indicated by the fact that of the 239 cases of acute appendicitis examined, 50 were of the gangrenous variety.

GANGRENE OF THE APPENDIX WITH A LARGE APPENDICULAR CALCULUS. CIRCULAR AMPUTATION OF THE APPENDIX AT ITS ATTACHMENT TO THE CECUM.—The patient, aged thirty-six years, formerly a student and an athlete, had always enjoyed good health. On November 15, 1895, after a long ride in a cold damp wind, he was suddenly seized with what seemed at first to be a severe attack of indigestion. Within a few hours the pain became intense; there was tenderness on pressure over the region of the appendix; abdominal distention soon followed, and was associated with constipation. Calomel and one ounce of Rochelle salts by the mouth, and two ounces of Epsom salts in hot water as an enema, were soon followed by copious evacuations of the bowels. These led to subsidence of the pain and tenderness. In a few days, though not entirely well, he was able to attend to business.

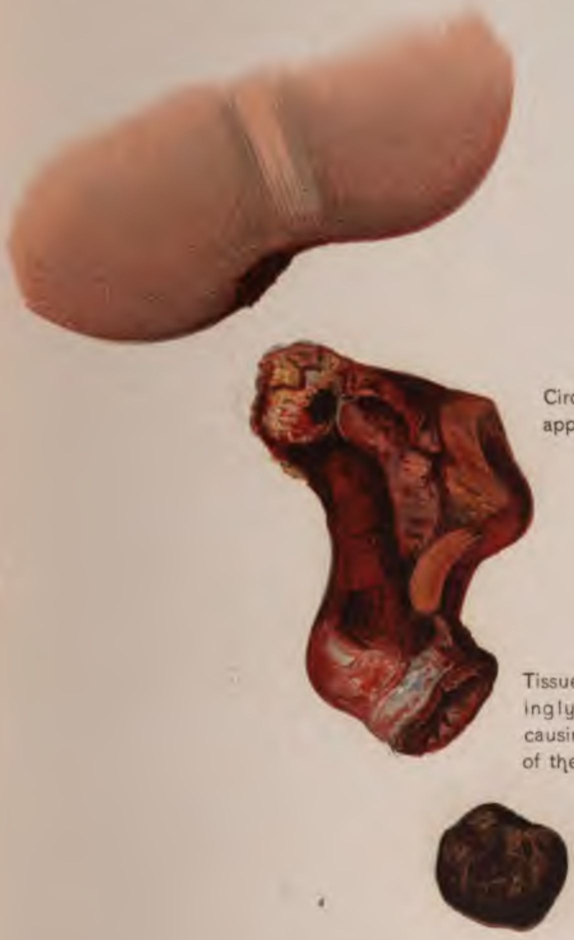
On December 15th, after a hearty meal, a second attack occurred. This also subsided after free purgation, but the patient remained in his previous condition of poor health.

On January 7th, there occurred a third attack, which did not entirely subside. Surgical interference was then decided upon.

The operation was complicated by a very fat and muscular abdominal wall. The appendix pointed north and lay behind the cecum, which was bound down. There was a very long and fat omentum and meso-colon. The appendix, which contained a large appendicular calculus, was enlarged, swollen, and gangrenous, and much resembled the fundus of the gall-bladder. It had been circularly amputated at its attachment to the cecum, revealing a large perforation. This was closed under most unfavorable circumstances. The meso-appendix contained a small collection of pus. Iodoform gauze drainage was carried down to and covered the sutures in the cecum in order to provide drainage in case the sutures should not hold. In protecting the general peritoneum and in the technic of the peritoneal toilet ninety pieces of gauze were used.

Recovery was uninterrupted. The case is rather exceptional in that the gangrene occurred to the proximal side of the appendicular calculus.

PLATE XIII



Circular amputation of the appendix from the cecum

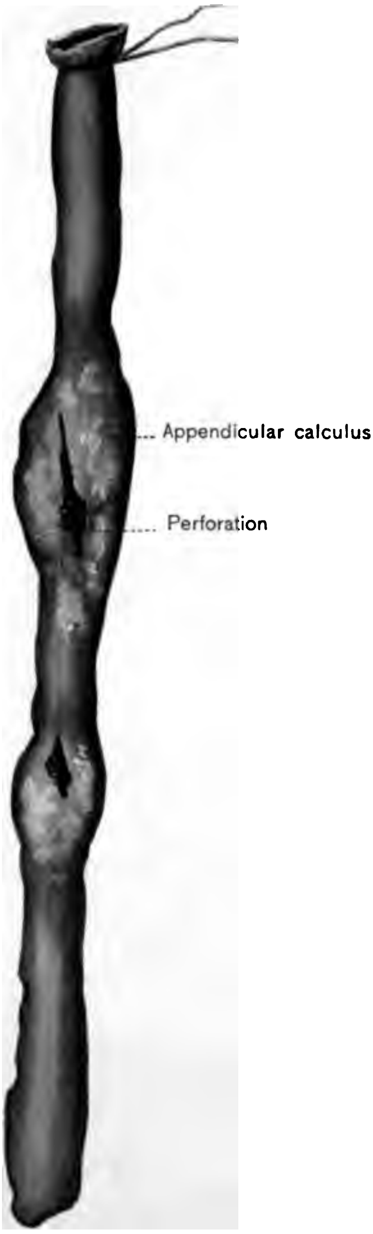
Tissue at the lower end exceedingly friable, slight pressure causing it to break with extrusion of the appendicular calculus

Gangrene of the appendix with large appendicular calculus. The cecum shows the point of circular amputation of the appendix.

Gangrenous appendicitis, or gangrene of the appendix, may arise in one of several ways. In the first place, as before indicated, any of the previously described varieties of inflammation of the appendix may progress to gangrene. While this eventually may ensue in the course of an inflammation that commenced as a catarrh, be it acute or chronic, it is much more likely to follow when the severer forms of inflammation affect the organ. In fact, in the event of gangrene we are usually justified in assuming a sudden severe infection in an appendix already the seat of disease. On the other hand, a sudden severe infection by virulent bacteria or their toxins of a previously healthy appendix may occur. This infection may be so intense and so overwhelming as to lead to rapid and fatal gangrene, possibly of the entire appendix, before an opportunity has been afforded the tissues to set up counteracting inflammation. Exceptionally, infection may be so intense as to lead to the death of the patient before necrosis has become marked or peritonitis has developed. It is, however, merely a matter of time when the necrosis becomes absolute and peritonitis of a virulent type supervenes. Again, gangrene of the appendix may be caused by sudden and complete withdrawal of the blood supply from the entire organ or from part of it. This may be induced by twists, angulations, etc., or may follow thrombo-phlebitis or thrombo-arteritis consequent upon interstitial or ulcerative appendicitis.

Macroscopy.—If the gangrene occur in the sequence of ulcerative appendicitis, the naked eye appearances detailed in connection with that variety of appendicitis are considerably exaggerated, both in degree and extent. A quarter, a third, a half, even the entire organ, may assume a dirty greenish-black color; it may become swollen, malodorous, and softened, and may finally become detached from the remainder of the organ or from the cecum (Plate XIII) as the case may be. The gangrenous area presents the appearance of moist gangrene generally. That region from which the gangrenous area has become separated by ulceration is reddened, raw, hemorrhagic, and the seat of newly formed granulations. The remainder of the appendix, if the entire organ is not gangrenous, presents

GANGRENE OF THE APPENDIX WITH PERFORATION.—The patient, aged fifty-six years, was taken ill suddenly on the evening of July 23, 1895, with severe abdominal pain. There was a history of similar attacks, which had been treated as ordinary colic. Examination by his attending physician disclosed a distended abdomen and tenderness in the right iliac region. The pain and tenderness, both of which persisted, were especially marked over the site of the appendix. I saw the patient on the evening of the second day, and advised operation, which was delayed for two days. The operation, when finally performed, revealed a very long and gangrenous appendix, situated post-cecal and post-colic. It was perforated, was surrounded by pus, and contained several appendicular calculi. There was also pus in the pelvis. Glass and gauze drainage were employed. The patient was the subject of chronic interstitial nephritis. For two days following the operation vomiting and hiccup were persistent. Recovery eventually ensued.



Gangrene of the appendix with perforation, illustrating the result of occlusion of *the lumen beginning* at a point other than the tip.

the appearances detailed in connection with the macroscopy of interstitial and ulcerative appendicitis.

If the gangrene be the result of sudden acute infection, at the end of a short time—from twenty-four to forty-eight hours—the entire organ or a portion of it may be completely deprived of its vitality. The same thing may happen if the blood supply be withdrawn. The portion of the organ affected is distinctly greenish-black in color; it is increased in bulk, much softened, and of a characteristic gangrenous odor. It may still be attached to the remaining portion of the appendix or to the cecum, and if but a portion be affected, the remainder is in a high state of interstitial inflammation, and is separated from the gangrenous area—at least, after the condition has existed for some time—by a more or less well-developed line of demarcation.

In this variety of appendicitis the pathologic alterations and the clinical manifestations may develop with such rapidity as well to merit the designation *fulminating appendicitis.* There may occur within a short time a complete circular amputation of the entire appendix (Plate XIII) or gangrene of a considerable portion of it—conditions that have been spoken of as *sloughing of the appendix.* In some such cases sufficient time has not elapsed for the formation of peritoneal adhesions, and thus—in contradistinction to the other varieties of appendicitis, in which the organ is commonly surrounded and more or less fixed by adhesions—the appendix may be found to be totally gangrenous and completely detached from the cecum and free in the peritoneal cavity. In other cases it may be found separated from the appendix and free in a circumscribed abscess.

The matter exuding from the opened lumen of such gangrenous appendices is usually pus. At times appendicular calculi may be found (Plate XIV), either in the lumen, projecting from it, or in the surrounding purulent matter or exudate. In 49 of the cases of gangrenous appendicitis examined they were found in 5 (10.2 per cent.). Doubtless others, however, at the time of operation had already escaped from the appendix and were not detected in the surrounding exudate or pus.

GANGRENE OF THE APPENDIX.—The patient, aged seventeen years, suffered with acute appendicitis. His condition being extremely precarious at the time of operation, it was considered wise to evacuate the abscess only. Instead of the abdominal wound healing completely, there remained two fistulous tracts, from which fecal matter escaped. Ten weeks later operation for the removal of the appendix was undertaken. It was found that, with the exception of the tip, but the upper half remained, these two portions being connected by a band of the meso-appendix. The openings in the appendix were in communication with the two fistulous tracts.

Recovery followed.

PLATE XV

Fig. 1

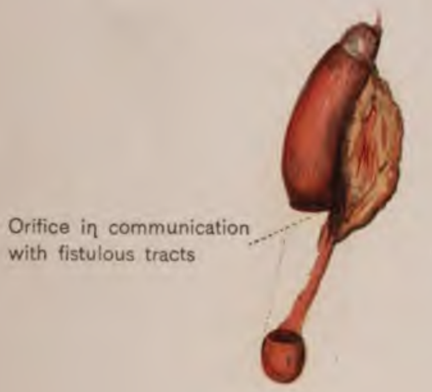
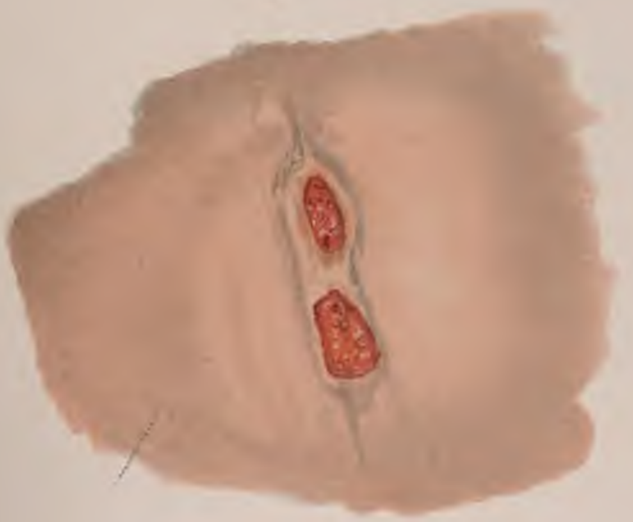


Fig. 2



Gangrene of the appendix

FIG. I. Complete gangrene of a portion of the appendix—the remaining portions connected by a bridge of the meso-appendix.

FIG. 2. External orifices of the fistulous tracts in communication with the *lumen of the remaining portions of the appendix*

As already indicated, the gangrene may affect the whole or a portion of the appendix. There may occur a circular amputation anywhere, or but a portion of the circumference may be involved. Most unusual and remarkable conditions are sometimes encountered. An instructive instance is the case illustrated in Plate xv, in which, at a secondary operation for the cure of two fistulous tracts persisting after a primary operation, the appendix was found to consist of the tip connected with the proximal half by a band of the meso-appendix. The opening in the appendix was in communication with the two fistulous tracts. Jopson reports a somewhat similar case: A fistula—from which there was a profuse mucous discharge, giving the chemic and microscopic reactions for mucin—persisted after an operation at which the appendix was not located. At a secondary operation the stump of the appendix was found in communication with the sinus; it was entirely separated from the cecum and was removed a considerable distance from it. Its mucous membrane was preserved, accounting for the mucous discharge. It had received its nutritive supply from vessels coursing in the numerous adhesions in which it was embedded. Frankfurter records a case in which circumscribed gangrene affected a portion of the wall of the organ, which disappeared. A bridge of tissue—remnants of the wall at the site of the gangrene—united the distal and proximal portions of the appendix. Roux records a case in which the appendix, amputated at its middle, was embedded in peritoneal adhesions. The amputated distal portion, which had become converted into a fibrous cord and was much distorted, was nourished by an artery, evidently newly formed, coursing in a band of adhesions springing from the region of Poupart's ligament. The proximal portion was nourished, as originally, by a branch of the appendicular artery coursing in the remnants of the meso-appendix. Fowler relates the case of a patient, aged eighteen years, who developed general peritonitis on the seventh day of an apparently ordinary attack of appendicitis. At the time of operation nothing was found of the appendix except the mucous membrane, forming a closed sac in which there was a fecal concretion. The remaining coats had become gangrenous and disintegrated. Despite the presence of the concretion, perforation of the mucous membrane had not taken place. The peritoneal cavity contained sero-purulent fluid. Many other curious cases have also been reported.

Microscopy.—Those portions of the appendix actually the seat of gangrene naturally present no structure that can be identified with certainty. Other portions of the organ present all gradations from moderate interstitial inflammation and ulceration to actual gangrene. If gangrene follow catarrhal or interstitial inflammation with ulceration, in certain regions—unless the entire appendix is already gangrenous—there is more or less extensive destruction of the surface epithelium, and to some extent also of the protecting basement membrane. It is not improper to assume that this latter structure is of considerable importance in protecting against infection. The exposed and unprotected mucosa and submucosa afford a congenial soil whence infection of the entire wall is a matter readily accomplished. In addition, there are noticeable high grades of interstitial inflammation, with abundant round-cell infiltration, suppurative foci, larger and smaller areas of hemorrhage, and more or less extensive necrosis. The individual cells present plasmolysis, chromatolysis, karyorrhexis, and hyperchromatosis. Adipose tissue becomes converted into free fat and fatty acids, muscle fibers become indistinct and dissolved, and the entire tissue breaks down into a granular and semi-fluid debris. Hemorrhages ensue, either from erosion of the vessels or, not uncommonly, from the result of the direct action of the bacteria and their toxins on the vessel walls. If a line of demarcation have formed, it presents, on the one hand, all the evidences of liquefaction necrosis until the sphacelus is cast off; and, on the other, the ordinary evidences of inflammatory reaction—commonly, however, with but slight manifestations of regeneration. If the gangrene be the consequence of sudden severe infection with very virulent bacteria, or of the sudden and complete withdrawal of the blood supply consequent upon twists, flexures, thrombo-phlebitis, or thrombo-arteritis, the entire appendix or a large portion of it presents evidences of very diffuse gangrene without manifestations of reactive inflammation. Under such circumstances the gangrene affects a large portion of the appendix uniformly, and does not appear to have been the result of the progression of the other varieties of inflammation of the appendix. The deeper layers of the organ are quite as much involved as the superficial.

CHRONIC APPENDICITIS.

In some presumably diseased appendices, particularly in some of those removed from patients presenting clinical evidence of chronic appendicitis, histologic alterations are not especially conspicuous. In a few instances they are not more marked than are those sometimes detected in appendices removed at necropsy from subjects who during life presented no definite indications of appendicitis. In some cases the only tangible and unmistakable evidences of disease are peritoneal adhesions binding the appendix to various tissues or organs. Thus, the query naturally arises: When is the appendix to be regarded as pathologic? It need hardly be stated that in a number of cases, especially of chronic appendicitis, a microscopic examination of the organ must be made before a trustworthy opinion as to its condition can be formulated.

In many instances disease of the appendix has been detected postmortem in subjects who during life manifested no noteworthy clinical evidences of such deviations from the normal. Thus, Kraussold states that one-third of all adult bodies reveal diseased appendices; Toft found the appendix diseased in 100 out of 300 subjects upon whom he performed necropsies; Hawkins detected evidences of past or present disease of the appendix in 16 out of 100 subjects. Personally, I believe that careful macroscopic and microscopic investigation will reveal indications of disease in at least one-third of presumably normal appendices removed from adults. Kelynack, on the other hand, believes that the statistics of Ransohoff—who found diseased appendices in 8 out of 60 subjects—represent more nearly the usual proportion. In many of these cases there can hardly be any question that the patients did not present any evidences of serious disease; on the other hand, the appendix can not be regarded as normal. It is not likely that the lesions began acutely; rather, they commenced chronically, insidiously, and it is but fair to assume that, had the patients lived long enough, they would inevitably have suffered the evil consequences of these morbid changes. In other cases the patients complain of various indefinite abdominal symptoms that are referred to disease of one or another of the abdominal organs. At times, however, the affection is recognized as chronic appendicitis, and the good effects attending operation for the excision of the offending organ sufficiently attest that even minor pathologic alterations of the appendix may give rise to more or less aggravated and persistent clinical symptoms. Many of these cases doubtless belong to the class that Ewald has incorrectly designated *appendicitis larvata*. Rather should they be termed cases of appendicitis difficult of diagnosis. They should not be confounded with those cases that Nothnagel, among others, has recently described under the caption of hysteric mimicry of appendicitis. The hysteric nature of a case of suspected appendicitis should not be especially difficult of recognition.

Many patients not in the least hysteric suffer severely and repeatedly from more or less aggravated attacks of recurring appendicitis; and still, in some instances, the appendix, when excised, presents but minor pathologic alterations. Sonnenburg reports a case in which, extending over a period of years, there occurred thirty attacks (some of them severe) of appendicitis, and yet when the appendix was removed it was pale, white, and soft. No details, however, are given of any microscopic examination. Doubtless in some cases the inflammatory phenomena subside with greater or less rapidity, and in the absence of extensive histologic evidence of disease, it is not always warrantable to assert that the removal of a given appendix was not justified. It must further be admitted, in view of the difficulty sometimes experienced in distinguishing between the results of inflammatory disease and certain developmental anomalies and retrograde alterations, that, in certain isolated cases, the clinical history is of decisive importance. All of the foregoing, however, are exceptional cases. Ordinarily, there is no difficulty whatever in recognizing the lesions of chronic appendicitis.

CHRONIC CATARRHAL APPENDICITIS.

By chronic catarrhal appendicitis is understood a chronic inflammation of the appendix in which the pathologic alterations are wholly or almost wholly confined to the mucous membrane, the other coats presenting little or no deviation from the normal. This is a very uncommon variety of appendicitis, for the reason that the causes inducing the inflammation, from their very nature, entail consequences that render the limitation of the pathologic alterations to the mucous membrane extremely unlikely. There can, however, be no question that cases of catarrhal appendicitis do occur. They are cases that clinically pursue a mild course, being, possibly, now and then subject to minor acute exacerbations. The clinical history of some cases of appendicitis indicates the existence of appendicular disease for a considerable period of time, and yet examination of the excised appendix reveals only catarrhal lesions. The occurrence of such cases has been indicated by various observers from time to time. In particular, Siegel reports a case in which, clinically, there had been severe pain, extending over periods of years, and in which, outside of catarrhal inflammation, the appendices exhibited neither macroscopic nor microscopic evidences of disease. Of the 305 chronic cases examined by the author, 6 were of this variety.

Macroscopy.—Macroscopic examination shows the appendix to be a little thicker, stiffer, and firmer than normal. On incising it, the mucous membrane is found to be of a grayish color and somewhat thickened. The crypts of Lieberkühn are moderately distended and the mucous membrane is covered with a layer of rather thick mucus. This mucus may also fill more or less completely the lumen of the organ. There is, however, commonly associated with the mucus, some fecal matter, or, rarely, a calculus. The caliber of the lumen may vary somewhat at different levels, usually as a result of previous attacks of inflammation. If to such chronic catarrhal inflammation there be added an acute exacerbation, the evidences of the latter, as already narrated, will be manifest.

Microscopy.—The crypts of Lieberkühn are more or less

CHRONIC INTERSTITIAL APPENDICITIS.—The patient, aged thirty years, had always been rather delicate, but enjoyed comparatively good health except for mild chronic intestinal dyspepsia, with occasional acute exacerbations. In May, 1895, she had an attack of what was believed to be intestinal dyspepsia of more than usual severity. The attack was accompanied by diarrhea and pain, referred to the region of the appendix, but recovery followed in a few days. On December 7, 1895, she was suddenly seized with acute agonizing pain in the abdomen, which was followed by diffuse tenderness and rigidity of the entire abdominal wall, and by nausea and vomiting. This condition yielded to the administration of laxatives and hot applications locally. The nausea and vomiting subsided and the tenderness became localized in the region of the appendix. The temperature never rose above 102° F. On the tenth day a slight exacerbation of the pain was caused by dietetic indiscretion. Two hypodermic injections of morphin and copious enemas were administered. Rectal feeding was carried out until the stomach became retentive. Although recovery was progressing satisfactorily, operation was decided upon, and was performed January 18, 1896.

The appendix was enlarged, congested, and firm to the touch. Its mucous membrane was congested and indurated, and presented slight superficial ulcerations. The lumen of the distal third of the organ was completely obliterated.

Recovery was uninterrupted, and was followed by decided improvement of the old intestinal symptoms.

PLATE XVI

Fig. I

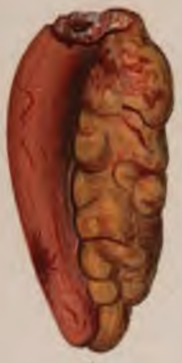
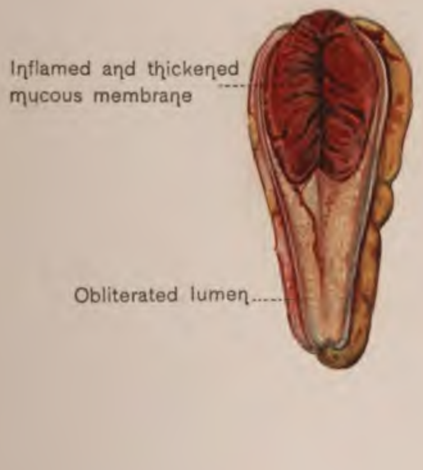


Fig. 2



Chronic interstitial appendicitis

FIG. I. External aspect of the appendix illustrating thickening of the wall of the organ and congestion of the subperitoneal blood-vessels.

FIG. 2. Internal aspect of the appendix illustrating congestion, induration, and superficial ulceration of the mucous membrane, and complete obliteration of the distal third of the lumen.

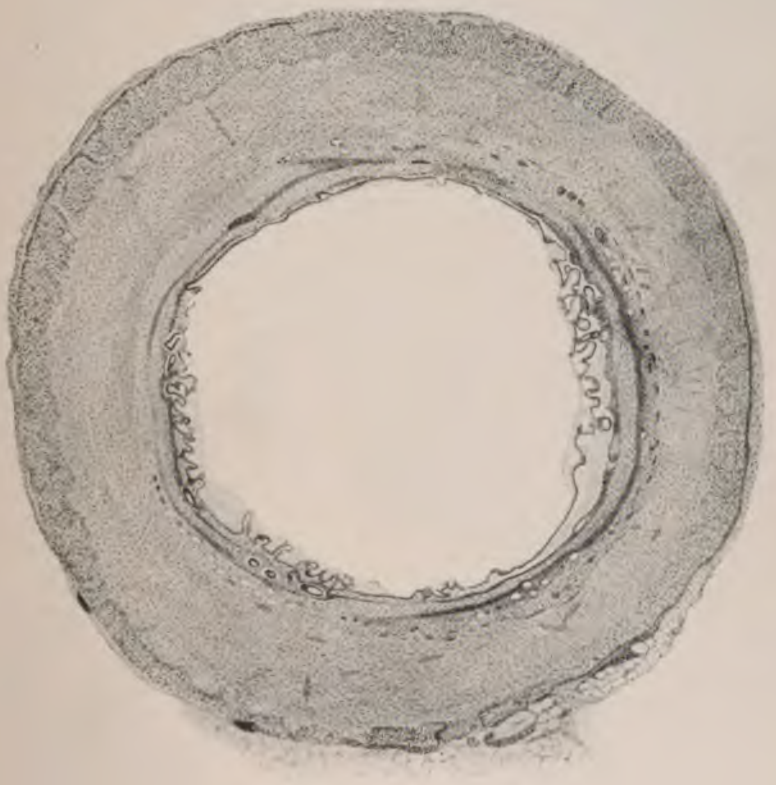
than calculi, as, for instance, tuberculosis, bacterial toxins, acute exacerbations of inflammation, etc.

On the other hand, there may be complete obliteration of the lumen of the appendix at one or more points along its length. It is readily conceivable that in the event of annular ulceration, granulating surfaces being everywhere opposed to granulating surfaces, these adhere, and, as the processes of regeneration and organization go on, become permanently united by means of newly formed connective tissue. Such obliteration of the lumen may be circumscribed or generalized. In the latter case obliterating appendicitis results; in the former, merely a local obliteration. The latter may be situated anywhere, and not uncommonly gives rise to a condition known as *cystic dilatation*, *retention cyst*, *hydrops*, or *mucocele* (Féré) *of the appendix.* (Plate XVII.) This is a condition in which that portion of the appendix distal to the obliteration becomes distended and filled with fluid. It was first recognized by Virchow, who spoke of it as colloid degeneration of the appendix. Depending upon the site of the obliteration, a portion of the appendix or the entire organ may be affected. Commonly, the dilatation is confined to the distal half of the organ, but the entire organ is relatively often involved. Rarely, a central portion may be implicated, the tip and proximal portions being free. Under such circumstances, however, the tip is much more likely to be entirely obliterated.

These cystic dilatations vary much in size. At times they are not much larger than a walnut, but instances of excessive size have been reported. Virchow stated that they might reach the size of a large fist. One removed by Deaver from a woman, aged twenty-five years, who had had two attacks of appendicitis, was the size of a small orange, and was adherent both to the neighboring coils of small intestine and to the right broad ligament. The lumen of the appendix was entirely occluded ¼ of an inch from its cecal end.

In shape they may be ovoid, cylindroid, round, or irregular. The character of the contained fluid also varies. It may be clear or slightly turbid, tenacious, gelatinous, or sometimes more limpid and watery. Leube long ago drew attention to

CHRONIC INTERSTITIAL APPENDICITIS—CYSTIC DILATATION OF THE APPENDIX.—A transverse section through the appendix at the seat of marked distention. The section shows the mucous membrane markedly thinned, flattened, and atrophic. In many places it has been reduced to a single layer of epithelial cells. To the right it has become detached in the preparation of the section. There is also marked atrophy of the lymphoid follicles and considerable hyperplasia of the muscular coats. Hematoxylin-eosin preparation. × 70.



the fact that at first the contained fluid consists of tenacious mucus, and that it later assumes the characteristics of a watery serum. This ensues because the wall of the appendix, as it becomes distended, usually also becomes thinned, its inner surface growing smooth and the distribution of its vessels being more superficial than normal. This results, on the one hand, in facilitating the escape of the watery portion of the blood, and, on the other, in reducing to a minimum, the formation of mucus.

Some very unusual conditions have been reported. Thus, Coats, Weir, and Kelynack have observed cases in which the contents were gelatinous in character. In Kelynack's case "the appendix was greatly distended, and presented two very distinct diverticular processes, which were directed beneath the folds of the mesentery of the appendix. The diverticula were connected with the dilated cavity of the appendix through well-defined circular openings." Hawkins states that there is a specimen in St. Thomas' Hospital Museum that shows five or six diverticula on the surface of the cyst. Hawkins, Bland Sutton, and Page report cases in which the contents consisted of purulent matter; but these were probably ordinary empyemas of the appendix. Fenwick reports a case in which the appendix was distended by a "milky fluid." Guttman reports a case in which the dilatation was 14 cm. in length and 21 cm. in its greatest circumference. In the case illustrated in Plate XVII the contents were quite clear and were somewhat tenacious.

Not all cases, however, are due to obliteration of a portion of the lumen of the appendix; sufficient obstruction may be produced by a very acute angulation. An instructive case of this sort has been reported by Treves and Swallow. A tumor two inches in length and one inch in diameter was made up of the appendix acutely bent upon itself and distended with mucus. The angulation was maintained by old peritoneal adhesions. When this was relieved, the contents escaped of their own accord.

The development of this condition of cystic dilatation of the appendix depends upon several factors. The obstruction of the lumen must be complete, or almost so; the obstruction or obliteration must have obtained at a time when the affected portion of the organ contained no pathogenic micro-organisms; the mucous membrane of the affected portion must be intact, or at least capable of functionating; and the secretion by the mucous membrane must be more rapid than the absorption from the portion of the appendix involved. If the obstruction be not complete, the secretion is likely to be forced through even a narrow opening with sufficient rapidity to prevent a large accumulation, and, on the other hand, infection is likely to occur through the patulous lumen, converting a cystic dilatation into an empyema. If there are already virulent bacteria in the affected portion of the appendix, an empyema, of course, rather than a cystic dilatation, will develop in the first place. (Plate IX.) If the mucous membrane is incapable of functionating, there can be no accumulation of fluid, and the same is also true if absorption be more rapid than secretion.

The condition is readily recognized as cystic dilatation of the appendix. The mucous membrane is usually smooth, and is generally in a high state of atrophy as a consequence of mechanical pressure. There is also marked atrophy of the lymphoid follicles. If the distention be but moderate, it is not uncommon to find the wall much thickened, as a result of compensatory hypertrophy of the muscular coats, and also of some connective-tissue hyperplasia. (Plate XVII.) Both these conditions, as evidences of chronic inflammation, as is mentioned elsewhere, may have developed prior to the hydrops. If with the occurrence of the distention the wall does not increase still more in thickness, it is likely to become much attenuated under the influence of the progressive accumulation of the fluid.

Microscopy.—The microscopic appearance of the extirpated appendix in cases of chronic appendicitis varies considerably in different instances. In some cases in which the clinical manifestations have extended over a period of some years the microscopic evidences of disease are very slight. In these cases, however, the indications of disease are self-evident from the macroscopic appearances, the distortions of the organ, and the chronic peritoneal adhesions. Even in these cases, however, careful microscopic examination will usually detect some of the catarrhal alterations already detailed in connection with chronic catarrhal appendicitis and some hyperplasia of the submucous or muscular coats or of both. In addition, there will commonly be noticeable more or less round-cell infiltration. In other cases the hyperplasia of the submucous and muscular coats is excessive, and there is considerable round-cell infiltration, which is usually scattered in small amounts throughout the various coats. If the lesions of the mucous membrane, already referred to, are not present, there is commonly more or less atrophy of this structure, and in some instances it is replaced by cicatricial connective tissue—the lumen, under such circumstances, being very narrow. In most cases of chronic appendicitis a hyaline degeneration of the submucous and muscular coats is a rather conspicuous feature. This varies in extent in different cases, at times being minimal, at others quite diffuse. If the appendix be examined while the process of cicatrization of an ulceration is in progress, remnants of the mucous membrane may still be detected. This, however, is not usual. On the contrary, what remains of the mucous membrane and submucosa is the seat of extensive round-cell infiltration, which is present also, to a greater or less extent, in the muscular coats. As a consequence of this round-cell infiltration, and of some hyperplasia of the submucous and muscular coats, the wall of the appendix is thickened and noncollapsible, and peristalsis is inhibited. Conditions are favorable, therefore, for the approximation of the opposed granulating surfaces—the free edges of the lumen—and for the formation of adhesions. In many cases delicate strands of embryonic connective tissue may be seen bridging the narrow slit—remains of the lumen—and uniting the opposed surfaces. In the early stages of this process, however, these strands are so delicate that they are frequently torn in the manipulations necessary for the preparation of the sections, and hence may be overlooked. Newly formed blood-vessels are frequent, and about these there spring up new granulations, which tend to cicatrization and to the formation of fibrous connective tissue. Obliteration of the lumen at some point may now be complete. Cicatrization continues, and the diameter of the appendix becomes, in consequence, gradually lessened. The blood vessel walls are often thickened, and at times there is interstitial hyperplasia of the nerves, especially of those of the meso-appendix. There may also be some proliferation of the endothelium of the blood vessels.

OBLITERATING APPENDICITIS.

By obliterative or obliterating appendicitis is understood a variety of interstitial inflammation of the appendix attended by or leading to obliteration of its lumen. Of the 299 cases of chronic interstitial appendicitis examined, 6 were recognized as of this subvariety.

Macroscopy.—Upon naked eye examination such appendices, as a rule, do not differ materially from those described under the heading Chronic Interstitial Appendicitis. In some instances, however, the region of the obliteration of the lumen is made evident by a marked thinning of the appendix, which may be reduced to one-half or less of its original size. Exceptionally, it may be reduced to a mere filament; and if but a portion be so affected, this presents a marked contrast to the remaining portion, which may be normal in thickness, or even somewhat increased, as a consequence of hyperplasia of the muscular coats. Upon endeavoring to incise the organ—that is, to open its lumen lengthwise—the obstruction or obliteration of the lumen is encountered. This may be situated anywhere along the course of the appendix, and, depending upon the stage of the process, there may be friable bands of adhesions or an impervious band of dense cicatricial connective tissue. Indeed, the whole appendix may be converted into such an impervious band of connective tissue by obliteration of the entire lumen. Under such circumstances, of course, subsequent attacks of appendicitis are rendered impossible: that is, a so-called natural cure has resulted. But such an event is of great rarity. Usually, the obliteration is limited to a portion of the organ, which may be the tip, the distal third, a half, or more. At times, as already indicated, the obliteration may affect a portion of the appendix at a distance from the tip, and the latter, if its mucous membrane be preserved and functional, may subsequently become the seat of cystic dilatation. Appendices the seat of obliteration of the lumen are commonly embedded in a dense mass of fibrous adhesions, which, by contracting, tend to hasten the process of obliteration. Even if complete obliteration occurs, these adhesions, which remain, sometimes give rise to disastrous intestinal and other complications.

Senn, who has directed particular attention to the obliterating variety of appendicitis, speaks of varying degrees of contraction of the lumen of the appendix that he has encountered, and that differ in extent from slight stenosis to complete obliteration; and these cases he includes in his category of obliterative or obliterating appendicitis. It seems to me, however, that this is an incorrect interpretation of the pathologic conditions, and that it is much wiser to limit the designation obliterative appendicitis to those cases in which an actual obliteration of the lumen occurs, and to exclude those cases developing merely a constriction—a stenosis of the lumen. These are essentially different pathologically. In the latter the lumen is preserved, though it tends to become progressively smaller, and is always less than normal; it may be lined in part by epithelium, or in great part by cicatricial connective tissue, but there is still some opening through the stricture, just as there is through a stricture of the urethra, which is hardly spoken of as an obliterative urethritis. In the case of true obliterative appendicitis, however, the opposed surfaces of the lumen have become firmly united to each other, and the obliterating band is absolutely impervious. Were the designation obliterative appendicitis employed in all cases in which the constriction of the lumen becomes marked, many of the cases that I have included in the category of simple chronic interstitial appendicitis would necessarily be classed as obliterative,—a classification impossible of justification.

Microscopy.—The microscopic appearances of the appendices in cases of obliterative appendicitis do not differ from those described in connection with chronic interstitial appendicitis; they are merely more extensive. In extreme cases microscopic examination may reveal nothing but dense cicatricial connective tissue and a few muscle fibers, especially in the impervious bands mentioned.

There are several particular forms of chronic disease of the appendix that may be attended by ulceration and that demand special consideration. Of these, the most important are tuberculosis and actinomycosis.

Tuberculosis of the appendix (Plate XVIII) may be primary or secondary, miliary or caseous. Primary tuberculosis of the appendix must be accounted among the greatest of rarities, and it may be doubted whether any well-authenticated case of primary tuberculosis of the appendix has yet been recorded. Even in the event of detecting tuberculosis of the appendix alone, particularly at operation, it is hardly possible to assert with certainty that tuberculosis does not exist elsewhere in the body; that the condition is primary in the appendix. Of the occurrence of tuberculosis of the appendix in association with, or secondary to, tuberculous lesions elsewhere in the body a great number of instances have been observed. There are, however, no reliable statistics of sufficient magnitude upon which to base an opinion as to the frequency of their occurrence. Fenwick and Dodwell, who reported the records of the necropsies performed upon 2000 subjects dead of tuberculosis in the Brompton Hospital for Consumption, found that the intestine was the seat of ulceration in 500 (56.6 per cent.) out of 883 cases. In 85 per cent. of these cases the ileo-cecal region was involved; in 9.6 per cent. it was the only portion of the intestine that showed evidence of disease. From this region the frequency of implication diminished in both directions. Thus, the jejunum was involved in 28 per cent. of the cases; the duodenum, in 3.4 per cent.; the ascending colon in 51.4 per cent.; the transverse colon, in 30.6 per cent.; the descending colon, in 21 per cent.; the sigmoid flexure, in 13.5 per cent.; and the rectum, in 14.1 per cent. It was quite exceptional to find the appendix uninvolved when there was disease of the ileo-cecal region; in 17 of the cases the appendix was the only portion of the intestinal tract that presented ulceration. Whether or not this ulceration was tuberculous was not definitely determined.

Upon macroscopic examination tuberculosis of the appendix is likely to elude observation in many cases. The lesions may not differ materially from those of simple catarrhal inflammation or ulceration of the appendix. On the other hand, the entire mucous membrane may have become converted into a discolored caseous mass, with more or less extensive ulceration. At times the nature of the affection may be recognized by the detection of minute grayish tubercles in the floor of the ulcer, or similar tubercles may reveal themselves beneath the peritoneal coat of the organ. If there be extensive tuberculous disease elsewhere in the body, of course, the tuberculous character of the lesions of the appendix is more likely to be recognized. If the disease be of the miliary variety, it should not escape detection; it is usually associated with similar disease of other intra-abdominal organs or tissues, particularly the peritoneum. Tuberculosis of the appendix does not manifest any very marked tendency to perforation, though such eventuality may occur. In almost all cases there is associated a more or less circumscribed tuberculosis of the peritoneum. The lesions are eminently chronic, and tend to the formation of fistulas.

Upon microscopic examination the well-known lesions of tuberculosis are detected. There are more or less extensive formation of epithelioid cells, giant cells, and round-cell infiltration, with a varying amount of caseation and partial or complete degeneration of the cellular exudate. The lesions are prone to involve the lymphoid follicles and to spread along the submucous coat, possibly involving other tissues; but histologically they do not differ from similar lesions in other portions of the body. With appropriate staining procedures tubercle bacilli may be detected.

The appendix illustrated in Plate XVIII is an instructive case of tuberculosis of the appendix in which the lesions of the appendix probably antedated those of the general peritoneum.

Actinomycosis of the appendix is a rare condition due to the pathogenetic activity of the streptothrix actinomyces, or

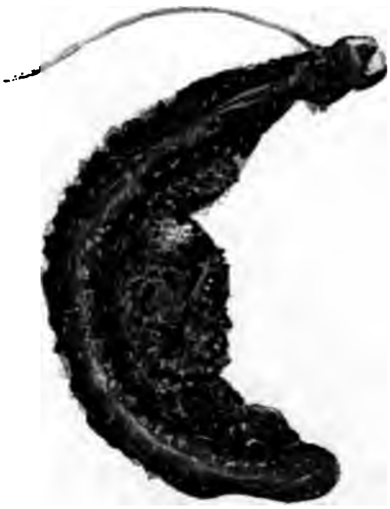
TUBERCULAR APPENDICITIS.—The patient, aged fourteen years, was admitted to the German Hospital on February 15, 1896, and the following history was elicited: During the past ten months he had had six typical attacks of appendicitis, but on each occasion operation had been declined. On the day prior to admission he complained of pain in the right side, which had grown rapidly worse until the entire abdomen had become involved. When examined, his temperature was 104⅗° F., his pulse-rate was 116, and his abdomen was enormously distended, tympanitic, and tender, particularly in the region of the appendix. The tenderness, however, was less marked than the amount of distention would lead one to expect. Rigidity was present only as part of the general distention, and was distributed equally. On the day after admission his temperature fell to 101° F., but rose again in the evening to 104° F. An area of dullness was found over the left lung posteriorly, but no tubercle bacilli were detected in his sputum. There was no record of tuberculosis in his family.

A diagnosis was made of tubercular appendicitis with subsequent involvement of the general peritoneum. Operation was advised and was agreed to.

Upon section of the peritoneum a small quantity of dark, odorless fluid escaped. The cecum and appendix were adherent by means of fibrinous exudate. The appendix, meso-appendix, and cecum revealed numerous miliary tubercles, which were also distributed throughout the general peritoneum. The cavity was irrigated, glass drainage was introduced, and the wound was closed. The patient died two months later.

PLATE XVIII

Tubercular appendix



The white spots represent miliary tubercles.

ray fungus. Actinomyces in man is itself a rather rare condition, and up to 1899 Ruhräh was able to collect from the literature but 70 cases reported in this country. Of these, the appendix was affected in 5. Hinglais, who has studied the appendico-cecal form, found it in 60 out of 100 cases of the abdominal form. Grill, in reporting four personal observations of the abdominal form of the disease, was able to find 107 other cases in the literature. In 40 of the latter the portal of entry of the actinomyces was definitely made out, and was as follows: The appendico-cecal region in 19; the colon in 8; the rectum in 7; and other portions of the intestinal tract (jejunum, duodenum, etc.) in 6. In 26 of the cases the process was perityphlitic and para-typhlitic, but no portal of entry could be definitely located; in 7, the process was peri-rectal; and in 36, the portal of entry was entirely indeterminate. Of Grill's 4 cases, one was probably an instance of gastric infection; the other three were peri-cecal or peri-appendicular. From the statistics of Sonnenburg and Grill it appears that up to the present time there have been reported 26 cases in which actinomycosis of the appendix was definitely made out. These are as follows: Barth (4), Boström, Braun (2), von Bergmann (2), Illich, Isräel (2), Langhans (2), Lanz (2), Lührs, Körte, Ponfick, Ransom, Regnier, Roux, Samter, Schreyer, Uzkow, and Vassilliew. To these may be added the cases reported by Ullman, Kern, Guder, Ekehorn, and Gangolphe and Duplant; the three cases reported by Czerny and Haeddeus; and the five cases collected by Ruhräh,—those of Lange (2), Latimer and Welch, Murphy, and Lee,—making a total of 39 cases. In one of Lanz's cases the actinomyces was detected in the stools of the patient.

Actinomycosis of the appendix may be the result of direct infection—through the intestinal tract; of indirect infection, or extension from the thoracic cavity—through the diaphragm, behind the peritoneum, or through the abdominal muscles; or it may be the consequence of metastasis. According to Hinglais, the affection may be divided into four stages: (1) The period of visceral symptoms, which may last from a few days to several months; (2) the period of tumor, which varies much in duration, and during which frequent remissions may occur; (3) the period of fistula, during which the disease may extend to other tissues, such as the lumbar region, the psoas muscle, the hip-joint, the space of Retzius, etc., and during which extensive abscess formation, with fistula, which are likely to be multiple, may develop; (4) the period of reparation, during which the affection may heal spontaneously or as a consequence of surgical procedures. On the other hand, the disease may persist indefinitely and may finally terminate fatally.

It is agreed by Boström, Johne, Ransom, Czerny and Haeddeus, etc., that it is most likely that the affection in these cases is primary in the appendix; that the fungus is carried to the appendix by some grain or fragment of corn or barley; and that this lodges in the appendix, wherein the actinomyces proliferates. Czerny and Haeddeus, from a careful study of their cases, conclude that there first occurs an infection of the appendicular mucous membrane, which becomes necrotic and gives rise to the formation of an ulcer. This permits of ready access of the actinomyces to the submucosa, wherein it further proliferates, and, meeting with slight resistance, extends in various directions. In one of their cases the mucous membrane did not appear ulcerated, and this fact is explained by supposing that, after the formation of the ulceration and the infection of the submucosa, reparation of the mucosa occurred, and that the necrotic mucous membrane was replaced by cicatricial connective tissues. These suppositions are confirmed by the absence of Lieberkühn's glands in the mucous membrane. Infection having occurred, suppuration, with the formation of fistulas, may supervene, or there may result the development of thick, indurative connective tissue. This differs from ordinary cicatricial connective tissue in that it contains small foci of pus, which may be absorbed if the fungus be absent. If the fungus be present, on the other hand, there may ensue further extension of the disease. In the peri-appendicular pus the characteristic grayish nodules may be detected. Upon microscopic examination these are found to be composed in whole or in part of the streptothrix actinomyces.

It has been pointed out by Barth, Partsch, and other observers that in those cases in which there occurs symbiosis, with the ordinary pyogenic cocci, the actinomycotic nature of the affection is likely to be nonapparent. It is only later, when, as a consequence of extension or metastasis, the disease develops in another portion of the body, that the true nature of the original infection is recognized. Probably because of this, and because some unsuspected cases have been cured at the primary seat of the disease, actinomycosis of the appendix seems more rare than it really is.

Other important pathologic conditions of the vermiform appendix are tumor formations.

Tumors of the appendix may be primary or secondary, benign or malignant, but they are very uncommon. In some search of the literature the author has been enabled to find but a single reference to benign tumors, and but few to malignant tumors of this organ. Lafforgue, in 1893, was able to find references to but seventeen tumors of the appendix. Among these there were one lipoma, one myoma, two lymphadenomas, two hydatid cysts, nine carcinomas, and two malignant tumors the nature of which was poorly defined. The two instances of hydatid cyst, or echinococcus, of the appendix are referred to on page 151.

Personally, the author has encountered two cases of fibromyoma of the appendix. One was from a patient the subject also of fibromyomas of the uterus, and both organs were removed at the same operation. The appendix presented two fibroid growths, each of which were spheroid in shape and about five millimeters in diameter. One was situated at the mid-point of the appendix, opposite the attachment of the mesentery; the other toward the tip of the organ, within the mesenteric attachment. They projected somewhat from the surface of the appendix, and each was well circumscribed, surrounded by a rather dense capsule, and was firm to the touch. On section they were whitish and glistening, and revealed a fibrillar structure. One was much harder than the other—being of almost stony hardness—and cut with a grating sensation. The wall of the appendix elsewhere was much thickened; the lumen much constricted. The mucous membrane appeared smooth and atrophic. On microscopic examination there were detected the lesions of moderate interstitial appendicitis (as already detailed), with considerable thickening of the walls of the blood vessels. The tumors consisted of bundles of dense fibrous connective tissue that coursed in various directions and intertwined among themselves, and interspersed between which there was a small amount of unstriped muscle fibers. The connective tissue contained relatively few nuclei and an abundance of intercellular substance. The blood supply was moderately good, but the walls of the blood vessels were thickened. The growth opposite the attachment of the mesentery contained a considerable amount of calcareous infiltration.* The second specimen was much like the first. There was, however, but a single nodule, which contained no calcareous infiltration. In other respects the resemblance was marked.

Although reports have been made of instances of carcinoma, sarcoma, and endothelioma of the appendix, malignant tumors of this organ must be accounted rare. An idea of the relative frequency of these new growths may be gleaned from a number of statistics that are now available. Madyl has reported the statistics of the Pathologic Institute of the Vienna General Hospital for the twelve years from 1870 to 1881, during which time 20,480 necropsies were performed. Among these there were 1460 cases of carcinoma, of which 100 affected the intestinal tract—its various portions as follows: Duodenum 2, jejunum 0, ileum 4, vermiform appendix 1, cecum 9, ascending colon 6, colon in general 17, sigmoid flexure 13, and rectum 48. To these Nothnagel has added the statistics of the same Institute for the twelve years from 1882 to 1893, during which time 20,358 necropsies were performed. Among these there were 2125 cases of carcinoma, of which 243 affected the intestinal tract—its various portions as follows: Duodenum 5, jejunum 0, ileum 6, vermiform appendix 1, cecum 14, colon in general 63, sigmoid flexure 40, and rectum 114. Thus, during twenty-four years, among 41,838 necropsies—3585 cases of carcinoma in general, 343 cases of intestinal carcinoma—the vermiform appendix was found the seat of the new growth in but two cases. Leichtenstern's statistics, based upon clinical and necropsy material, comprise 770 cases of intestinal carcinoma, as follows: 616 cases of carcinoma of the rectum, 42 of the sigmoid flexure, 11 of the descending colon, 30 of the transverse colon and the splenic and hepatic flexures, 6 of the ascending colon, 20 of the cecum, 3 of the appendix, 9 of the ileo-cecal valve, 13 of the lower portion of the ileum, 3 of the upper portion of the ileum, and 17 of the jejunum and duodenum. Bryant has collected a series of 110 cases of carcinoma of the intestine, in which the regions affected were as follows: The small intestine in 6 cases, the cecum and the ileo-cecal valve in 7, the transverse colon and the hepatic and splenic flexures in 19, the sigmoid flexure and the rectum in 78. Müller, among 5621 necropsies performed in the Pathologic Institute of Bern from 1886 to 1891, found 521 cases of carcinoma of the various bodily organs. Of these the rectum was the seat of the new growth in 19 cases, the large intestine in 13, the small intestine in 9 (the duodenum in 6 and other portions of the small intestine in 3). Ewald's statistics, a compilation of those of Maydl, Leichtenstern, Bryant, Müller, and others, are as follows: 874 cases of carcinoma of the rectum, 148 of the large intestine, 64 of the cecum and appendix, 26 of the ileum, 17 of the jejunum, and 19 of the duodenum. If to these we add the statistics of Nothnagel, we ascertain that of 1391 cases of carcinoma of the intestine, the rectum was the seat of the new growth in 988 cases, the large intestine in 251, the cecum and the appendix in 79, the ileum in 32, the jejunum in 17, and the duodenum in 24. Of the 79 cases in which the cecum and appendix were involved, it is impossible to ascertain from the reported statistics the number in which the appendix alone was implicated or the number in which it was primarily the seat of the neoplasm. The number, however, is certainly small. There seems to be clear evidence that the tumor formation was limited to the appendix in but five cases—one of Maydl's, one of Nothnagel's, and three of the compilation of Leichtenstern. To these may be added a sixth case, reported by Zemann, who found one instance of carcinoma of the appendix among 165 cases of carcinoma of the intestine in general. In addition to these, the author has been able to find references to but twelve other cases—those of Merling, Rokitansky (four), Prus, Beger, Draper, Stimson, Mossé and Daunic, Wright, and Cullen. Monks also has reported a case of carcinoma of the appendix and cecum; but which structure was primarily the seat of the disease does not appear from the report. As already noted, Lafforgue, in 1893, was able to collect from the literature the reports of but nine cases of carcinoma of the appendix. One of these, Bierhoff's, is admittedly an instance of secondary involvement of the appendix, and another, that of Kolaczek, implicated also the cecum. While from these statistics the rarity of carcinoma of the appendix is very manifest, I am inclined to think it is not so rare as it may appear. I have doubtless overlooked the reports of some cases, other cases have not been reported, and in many cases in which both the cecum and the appendix were involved the new growth was doubtless primary in the appendix. In addition to the previously mentioned cases, it is worthy of note that Glazebrook has reported a case of endothelial sarcoma of the appendix, and Kanthack and Lockwood a case of psammoma of the appendix and ovary.

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* This case has been reported by Dr. Deaver in the "Transactions of the Academy of Surgery of Philadelphia," vol. I, 1899, p. 23.

Personally, in an examination of 706 appendices removed by operation by Dr. Deaver at the German Hospital during 1897, 1898, and 1899, I have encountered three cases of carcinoma, and one case of endothelioma, of the appendix. No new growths were found in any of the appendices removed at necropsy.

CASE I.—*Carcinoma of the Appendix.*

The clinical history of the case, unfortunately, can not be found. The following are the notes of the macroscopic examination of the appendix (No. 21, 1898), which was removed by operation, February 19, 1898: The appendix weighs 8 gm.; its length is 11 cm.; its exterior diameter at its proximal end, 8 mm. This diameter is maintained for about 3 cm. of its length, when it increases to 1.2 cm., and continues of this diameter throughout the remainder of its length. The organ is irregularly distorted, and the wall of its proximal two-thirds is of greenish hue and is softened and necrotic. The wall of the distal third is thickened and congested. The lumen of the organ measures 4 mm. at the proximal end, and gradually decreases to measure 1 mm. toward the tip. The mucous membrane is much congested and ulcerated toward the proximal extremity. Toward the tip the inflammatory phenomena are less marked. The lumen contains a small amount of mucopurulent material.

Cultures revealed the bacterium coli commune in pure culture.

On microscopic examination the lesions of a high-grade ulcerative appendicitis (as detailed elsewhere) are observed. The meso-appendix is also the seat of marked inflammatory alterations. In addition, just distal to the necrotic portion of the appendix there is an area of tumor formation, which is about 6 mm. in diameter. It involves the mucosa and the submucosa—the muscular coats being unimplicated except for atrophy the consequence of the pressure by the neoplasm against the unyielding serous coat of the organ. There is some slight indication of persisting mucous membrane, which consists of the ordinary reticulum of the mucosa, the seat of extensive round-cell infiltration, and a few glands of Lieberkühn, which are hyperplastic and cystic. There is no surface epithelium lining the lumen of the appendix. The tumor formation consists of a connective-tissue stroma, which forms alveoli, within which the tumor cells are detected. These cells are arranged in nests, which vary much in size and general configuration. For the most part they are large and ovoid. Some of them are really very large and roundish; others are elongated and narrow. They consist almost exclusively of solid masses of cells. The individual cells are polyhedral in shape,—the result of mutual compression,—and they are distinctly epithelial in appearance. They have relatively large nuclei, which are clear and vesicular and stain well. The stroma, which is relatively inconspicuous as compared with the masses of tumor cells, consists of narrow bands of fibrous connective tissue, with a moderate number of elongated cells with rod-shaped nuclei. It is probably the altered submucosa. There is also a small amount of round-cell infiltration. The blood supply is not especially conspicuous.

CASE II.—*Endothelioma of the Appendix.*

The patient, E. S., a married woman, aged twenty-four years, was admitted to the German Hospital, March 24, 1898. Her father and mother had died of pulmonary tuberculosis, and one brother and one sister in infancy of causes not ascertainable. The patient had had measles, scarlet fever, and typhoid fever, the last-named at the age of nineteen years. Menstruation had been established during her ninth year, and had been regular since her tenth year. The flow was usually free, lasted about three days, and was accompanied by backache, headache, and nausea. There was also some leukorrhea. About a year prior to admission to the hospital she had had a severe attack of abdominal pain, which came on suddenly and was accompanied by vomiting. The pain is thought to have been diffuse, but nothing additional is remembered of the attack. Since then there have been three other attacks

—the last one three weeks prior to the date of admission. It began with general abdominal pain and vomiting. The pain soon became localized in the right iliac fossa, in which region there persisted constant pain and tenderness. The appetite was poor and the bowels were constipated. During the latter part of February, 1898, she had been operated upon in the German Hospital for *fistula in ano.*

Examination of the heart and lungs revealed normal conditions. On palpation of the abdomen, the appendix was easily outlined, and was found to point north. Vaginal examination yielded negative results.

At operation, performed March 26, 1898, the appendix was found free, and was excised from the cecum. Silk sutures were employed to close the opening in the cecum and silkworm-gut to close the abdominal wound, which was covered with an aseptic silver-foil dressing. The sutures were removed April 3d, and the patient made an uneventful recovery.

The following are the notes of the macroscopic examination of the excised appendix (No. 47, 1898): The organ is 9 cm. in length, and its diameter varies from 7 mm. at its proximal end to 5 mm. at its tip. Externally, it is of a bluish-red color. Its wall appears of normal thickness. The lumen measures 2 mm. in diameter throughout its length. The mucous membrane is thickened and congested. There is no meso-appendix accompanying the organ.

On microscopic examination there are detected the lesions of chronic catarrhal and interstitial appendicitis (as narrated elsewhere). They are, however, of minor grade. There is some thickening of the walls of the blood vessels. In addition, toward the base of the appendix there is a small area in which there is an infiltration of the wall of the organ with cells that vary much in general arrangement. In places, infiltrating between fasciculi of fibrous connective tissue or between bundles of muscle fibers, there are narrow columns of cells. These are frequently not more than one or two cells in thickness and may be ten or twenty cells in length. They are often pointed at their extremities, though in some sections they appear rounded, and they present a seemingly intimate connection with the surrounding connective-tissue stroma. Other collections of similar cells are much thicker and shorter, and are roundish, ovoid, or irregular in outline. Some collections, relatively, are of massive size and irregular contour. In other regions there is a distinct plexiform arrangement—an anastomosing network of these cells. The individual columns of these latter cells are usually very narrow except at their points of crossing or anastomosing. Not only do the narrow columns of cells exhibit an apparently intimate association with the surrounding connective-tissue stroma, but such association is general throughout the growth; that is, the sharp demarcation between the nests of tumor cells and the stroma that obtains in a carcinoma, the clear spaces that surround the nests of epithelial cells in the latter, are generally absent. In some portions of the growth there is a clear space about a collection of tumor cells, but this is usually within the nests of cells; that is, some cells—a single layer generally—

preserve an attachment with the surrounding stroma despite the detachment or retraction of other cells of the same group. The individual cells are polyhedral or irregular in shape; others, particularly those toward the pointed extremities of narrow columns of cells, are quite flattened. Their nuclei are of moderate size, and stain well and diffusely. The stroma supporting the tumor cells consists in part of fibrous connective tissue, in part of unstriped muscle fibers—the normal tissues of the appendix. The fibrous connective tissue presents in places relatively few cells and a large amount of intercellular substance, in part homogeneous and evidently the seat of hyaline degeneration. Even within the large collections of tumor cells a small amount of stroma can be recognized. This consists of fine trabeculæ, which serve to divide these large collections into smaller ones.

CASE III.—*Carcinoma of the Appendix.*

The patient, a man, J. M., aged nineteen years, was admitted to the German Hospital on March 11, 1899. His father, mother, four brothers, and five sisters were living and well. One brother and one sister had died in infancy of causes not ascertainable. He had always been well until eight days prior to admission, when he was suddenly seized with cramp-like abdominal pain. Upon the third day he vomited a small quantity of frothy mucus, and on this day also the pain became localized in the right iliac fossa. His bowels had been moved several times as a result of the administration of laxatives. On admission, the pain persisted, but was relieved by flexing the right thigh. There were some abdominal distention and tenderness in the right iliac fossa, marked rigidity of the right rectus muscle, an area of dullness, and, on palpation, a mass about three inches in diameter in the right iliac fossa. Appetite was poor, but there was no headache. His temperature on admission was 102° F.; the following day it rose to 103.2° F.

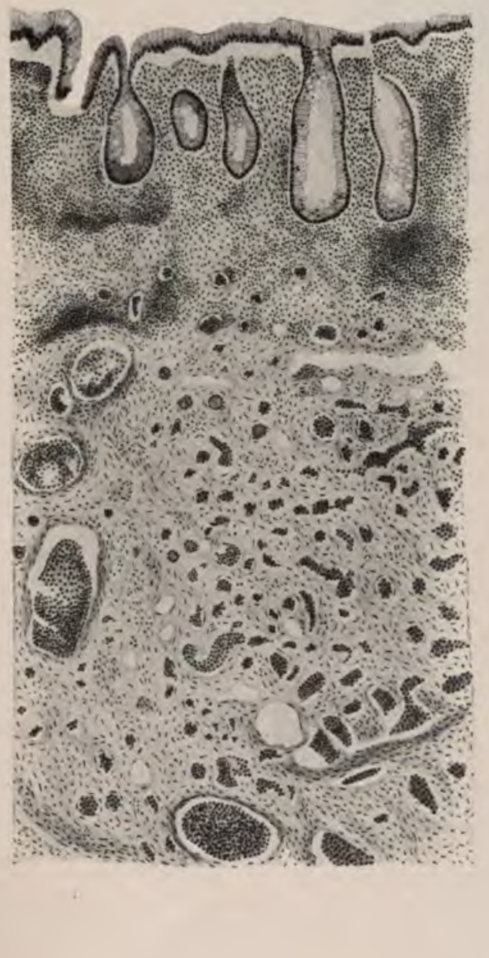
At operation, performed March 12, 1899, the head of the colon and the appendix were found surrounded by a small encapsulated collection of pus. This was evacuated and the appendix was removed. Gauze and rubber tubing were employed for drainage. The patient made a good recovery.

The following are the notes of the macroscopic examination of the excised appendix (No. 280, 1899): The organ is 5 cm. in length and about 1 cm. in thickness throughout its extent. It is much congested and inflamed, and is covered with a discolored fibrino-purulent exudate. This, when removed, shows the organ much distorted.

Cultures revealed the bacterium coli commune in pure culture.

Upon microscopic examination there are detected the lesions of ulcerative appendicitis (as narrated elsewhere). In addition, toward the base of the appendix there is a small new growth (Plate XIX), which in cross-section occupies hardly three-fourths of the microscopic field of a AA Zeiss objective and a No. 2 eye-piece. It is situated entirely within the submucosa—the superjacent mucous membrane being intact except for compression of its lowermost portion. The new growth consists of cells, which, infiltrating the submucosa, are arranged in solid masses or nests of varying size and conformation. They

PRIMARY CARCINOMA OF THE APPENDIX.—The section shows a portion of a small carcinoma limited to the submucosa. It consists of epithelial cells arranged in irregular nests that infiltrate the submucosa without definite arrangement. The nests vary much in size and configuration. Hematoxylin-eosin preparation. × 250.



are mostly very small; a few, however, are relatively large. Some are roundish in outline, others are very irregular. The individual cells are epithelial in appearance; they are of moderate size, and their nuclei are vesicular and stain well. The supporting stroma consists of the altered submucosa, which shows but a very slight amount of inflammatory reaction. In certain sections there is a slight amount of infiltration of the muscular coats with small numbers of the tumor cells.

CASE IV.—*Carcinoma of the Appendix.*

The patient, a man, T, R., aged sixty-three years, was admitted to the German Hospital, on August 11, 1899. His father and mother had died of causes unknown to him. Nothing was known of his brothers and sisters. With the exception of the ordinary diseases of childhood, and "colds" during the winter, he had enjoyed good health until recently, when he commenced to complain of attacks of abdominal pain, which were more severe in the right iliac region, and were accompanied by constipation. When the attack was severe, there were also nausea and vomiting. Lately the attacks had become more frequent than formerly, but they were always relieved by free purgation. When admitted to the hospital, the symptoms already narrated were complained of, and examination revealed tenderness over the region of the appendix. His temperature was normal; his pulse-rate, 116 a minute.

At operation, performed August 17th, the appendix was found intimately adherent to the surrounding structures. The adhesions were loosened and the appendix was excised from the cecum and the opening in the latter sutured. The appendix and intestines were studded with numerous miliary whitish or grayish-white nodules that suggested miliary tubercles. There was also enlargement of the retroperitoneal glands. The day following the operation the patient's temperature was 101° F., and the succeeding day it reached 102.4° F. The patient did well, however, and the temperature gradually subsided, to reach 99° F. on the evening of the sixth day. The following day the stitches were removed. The wound seemed healthy and there had evidently been union throughout; the abdomen was flat. The pulse, however, had remained rapid, and the patient had developed a cough. On the evening of the day on which the stitches were removed it was noticed that the dressings were soiled with blood. On removing these, the wound was found gaping widely and the intestines were presenting. There seemed to have resulted no union whatever, either of the peritoneum or of the structures of the abdominal wall. The patient was etherized and the incision was resutured. He was, however, much shocked; his pulse was weak and 170 a minute, and he died seven hours after the operation. No necropsy was permitted.

The following are the notes of the macroscopic examination of the excised appendix (No. 381, 1899): The organ is 2 cm. in length and varies in external diameter from 1 cm. to 2 cm., having a constriction about the center. It is firm to the touch and appears moderately congested. Scattered over the surface there are a number of small, miliary, grayish-white nodules, which suggest tubercles.

Microscopic examinations of sections from three regions of the organ reveal the normal appearances in none. In those from the center and the proximal end there is a lumen in the center of the section, but nowhere any indication of mucous membrane or lymphoid follicles. The sections from near the tip reveal no lumen. With difficulty, here and there some submucosa can be recognized, and also some more or less distorted and altered muscularis. Throughout the entire wall of the appendix, but especially in what may be taken for the submucosa, there are nests of cells that vary much in size and configuration. In the submucosa the arrangement is most irregular, and they course in various directions. In the muscular coats they run especially between and in the direction of the bundles of muscle fibers. For the most part these nests are elongated and narrow. Many, however, are very irregular in shape, and some are very large. Many of them appear as hollow cylinders, being composed of a single layer of cells surrounding a clear lumen. In some areas there is a double or a triple layer of cells; in others, there are solid nests of cells. The individual cells are distinctly epithelial in appearance; they are low cylindric or cuboid in shape—in the solid nests they are polyhedral. They have relatively large, clear, vesicular nuclei that stain well. In the stroma—which consists, as already intimated, of the altered submucosa and the muscularis—there is a moderate amount of round-cell infiltration. The meso-appendix is also the seat of carcinomatous infiltration.

Especial interest attaches to these four cases because in all the clinical symptoms were those of appendicitis, for the relief of which the operations were undertaken. In three—Cases I, II, and III—in addition to the new growth, inflammatory alterations were found. In these three cases also the tumor formation was doubtless primary in the appendix; in Case IV the involvement of the appendix was possibly secondary to a carcinoma elsewhere in the body. The entire absence of mucous membrane in the appendix, however, and the appearances of the carcinomatous cell formations, suggest that the new growth may have arisen in the appendix and may have subsequently implicated other structures. It is also worthy of note that in Cases I, II, and III the tumors were of microscopic size, and were not detected by the ordinary macroscopic examination. The youth of two of the patients, who were aged respectively twenty-four years and nineteen years, is also of interest.

THE PERITONITIS AND ITS CONSEQUENCES.

Although the dissociation of the lesions of the appendix from those of its serous covering (peri-appendicitis) and the peritoneum in general is at most an artificial one, there are several reasons, not alone of convenience, that render profitable the discussion of both separately. In the first place, similar lesions of the appendix, in different cases, may give rise to most diverse peritoneal lesions; that is, there is no constant relationship between the lesions of the appendix and those of the peritoneum. There can be no question that in certain cases of appendicitis the peritoneum presents no deviations whatever from the normal. These cases, however, are of comparative rarity, and are almost exclusively instances of catarrhal inflammation. But not all cases of catarrhal appendicitis are unaccompanied by inflammation of the peritoneum. Again, there are still rarer cases of fulminating appendicitis with rapid gangrene, in which the diseased organ may be excised by the surgeon, or the patient may die before there has been time for the development of peritonitis. Further, instances of chronic interstitial appendicitis with ulceration, unattended by evidences of implication of the peritoneum, have been recorded by several observers, among them Schede and Sonnenburg. But these are unusual cases. Excepting the previously mentioned instances, all cases of appendicitis are complicated by peritonitis, and it is for this reason that the designation appendicular peritonitis is most appropriate. It is because of the peritonitis to which it gives rise that appendicitis acquires the importance that attaches to it.

The reasons for the implication of the peritoneum in appendicitis are not difficult to find. The peritoneal covering of the appendix is, in reality, a portion of the organ itself, and it is readily conceivable that an inflammation that affects one or more coats of a tube such as the appendix should, under favorable circumstances, affect all. That certain cases of catarrhal appendicitis are unattended by peritonitis is equally plausible. In these cases the operations of the noxious agents provocative of the catarrhal inflammation are confined to the mucous membrane, either because of their attenuation or of the resistance offered by the other tissues to their further progress. On the other hand, the factors for the ready dissemination of the inflammatory irritants are found in the virulence of the bacteria and their toxins and in the anatomic construction of the appendix. The liberal lymphatic supply, and to a less extent the blood supply, must be held answerable for the conveyance of the irritants from one coat to the others.

The detection of bacteria in association with all varieties of peritonitis naturally led to the inference that there was some causal relationship between the former and the development of the latter. The demonstration experimentally that peritonitis follows the introduction into the peritoneal cavity of certain bacteria confirmed this view. The matter, however, is not so simple as at first sight appears.

In marked contrast to the opinions entertained some years ago, it has now been repeatedly demonstrated, both experimentally and otherwise, that the peritoneum is possessed of considerable powers of resistance to the action of all deleterious influences. These powers of resistance are comprised essentially in the following: (1) The bactericidal action of the peritoneal serum; (2) the great resorptive power of the peritoneum; (3) the marked tendency exhibited by the peritoneum to unite, to form adhesions, and cause circumscription—encapsulation of infectious foci. The first, the bactericidal action of the serum of the peritoneum, is probably of little importance, though it seems that it should not be entirely ignored. The second, the great resorptive power of the peritoneum, is of considerable importance. Bacteria that gain access to the peritoneal cavity may be destroyed *in situ* by the bactericidal activity of the peritoneal serum, which, as stated, is not conspicuous, or they may be robbed in great part of their pathogenetic powers by their rapid resorption by the peritoneum. This, it seems, is of considerable moment, and there is good reason for belief, that such is the rapidity with which bacteria are often absorbed by the peritoneum, that they are removed from the peritoneal cavity before they have had time to exert sufficient deleterious activity to engender inflammatory reaction.

Having been absorbed, they are finally destroyed by phagocytes in the lymph channels, blood vessels, etc. Frequently, however, neither of these factors suffices, and, in an effort to resist general infection, the peritoneum exerts itself to the utmost by uniting, forming adhesions, and leading to encapsulation of infectious foci. The exact nature of this process is still imperfectly understood; but the fact is well established that, as bacteria in cultures may die as the result of the action of the toxin they themselves produce, so in such encapsulated foci the contained bacteria, after the lapse of a certain time, gradually lose their virulence and finally succumb; and, that the cellular exudate undergoes various retrograde metamorphoses, becomes fatty, forms a granular debris, and is, partly at least, removed by absorption. It is not only the encapsulation and limitation of the infectious foci *per se*, but also the concomitant peritoneal lesions, that serve to protect against general infection. The obstruction of the lymphatic stomata and the regionary lymphatic radicles by the coagulated fibrin which also covers the serosa subserves the same useful purpose.

Appreciating the nature and character of the powers of resistance offered by the peritoneum, the comprehension of the mode of production of peritonitis is much facilitated. The introduction of nonpathogenic micro-organisms into a healthy peritoneum is without morbid consequences. The introduction of pyogenic micro-organisms into a healthy peritoneal cavity is not followed by peritonitis, provided the bacteria be not excessive either in number or in virulence. Peritonitis, however, does result from the access of pyogenic bacteria to the peritoneum when the bacteria are excessive in number or virulence or both; that is, when there are excessive demands upon the resorptive power of the peritoneum, be it that there is a sudden accession to the peritoneum of a large quantity of bacteria, or an intermittent or continuous supply of bacteria in small numbers; when the resorptive power of the peritoneum is below the normal; when the peritoneal cavity contains a quantity of fluid, particularly an albuminous fluid susceptible of decomposition—even a simple ascites is of significance; when the peritoneum is subjected to mechanical injury at the site of the introduction of the bacteria, such as occurs in case of operative wounds and rupture of intra-abdominal organs, as the appendix, etc.; and when the patient is debilitated.

The disastrous consequences of peritonitis are due in part, particularly in the purulent varieties, to the local suppuration, to the loss of the bodily fluids, but in great part to intoxication of the general organism. The paramount importance of this latter is evident from the fact that the most severe and rapidly fatal forms of peritonitis are unaccompanied by the formation of any appreciable exudate; hence they are not attended by loss of the bodily fluids. The clinical manifestations of the severe forms of this affection—such as disturbed cerebration, partial coma or delirium, pale and "leaky" skin, cyanosis of the lips and finger-tips, dry tongue, rapid and fleeting pulse, rapid and shallow breathing, etc.—are the manifestations of intoxication rather than of infection. The different varieties of peritonitis, however, present marked differences in the degree of accompanying intoxication. Thus, in many of the cases of circumscribed peritonitis the intoxication is but slight. In some of the suppurative forms with gangrene of the appendix it may, however, be quite marked. Of the diffuse forms of peritonitis, those attended by the formation of pus, though extremely virulent and producing marked toxemia, are less virulent and give rise to a less degree of toxemia than do the hemorrhagic forms and those marked by the absence of exudate. The latter, which may be designated toxic peritonitis, is accompanied by so extreme a degree of toxemia that the patient generally succumbs very quickly. The shock attendant upon the rupture of the diseased appendix is of itself not of so much significance in the sudden development of alarming symptoms as is the rapid absorption of a large quantity of preformed toxins that are suddenly evacuated into the general peritoneal cavity. It is under such circumstances that the great resorptive power of the peritoneum, of such significance in guarding against infection, becomes the very agent whereby the system is suddenly overpowered by a large quantity of these preformed toxins. The absorption also of a quantity of ptomains that are sometimes liberated with the toxins contributes to the production of alarming symptoms. At times, of course, the fatal issue is determined by pyemia rather than by intoxication.

Pathologically, the lesions of the peritoneum, like those of the appendix, may be acute or chronic as regards their course; circumscribed or diffuse as regards their extent; and serous, sero-fibrinous, fibrinous, purulent, or hemorrhagic as regards their character. Just as in the different varieties of appendicitis, there may also be all gradations, from the mildest peritoneal implication to the most virulent—from those with slight circumscribed serous exudate to the most severe, malignant, generalized, purulent, hemorrhagic, or toxic peritonitis. Nevertheless, there are attending the various forms of appendicitis several varieties of peritonitis which differ as to their mode of production, extent of implication of the peritoneum, and character of the exudate, and which, in consequence, permit of a practical classification of the peritoneal lesions of appendicitis. These will be described as follows:

I. Acute Appendicular Peritonitis.
    1. Circumscribed serous, sero-fibrinous, and fibrinous peritonitis.
    2. Circumscribed purulent peritonitis, or peri-appendicular abscess.
    3. Diffuse or generalized peritonitis.
II. Chronic Appendicular Peritonitis.

ACUTE APPENDICULAR PERITONITIS.

CIRCUMSCRIBED SEROUS, SERO-FIBRINOUS, AND FIBRINOUS PERITONITIS.

By serous or sero-fibrinous peritonitis is understood an inflammation of the peritoneum attended by the formation of a serous or sero-fibrinous exudate. Of all the varieties of peritonitis complicating appendicitis, the serous is probably the most infrequently met with, and, in consequence, but little attention has been directed to it. Its apparent uncommon occurrence is due not so much to its actual nonexistence as to the fact that at the time of observation, either at operation or necropsy, it has given way to one of the severer forms of peritonitis. As a result, however, of the practice that has obtained in recent years of operating early in cases of appendicitis, sufficient opportunity has been afforded to note the not uncommon occurrence of such serous or sero-fibrinous peritonitis.

It is but natural to infer that if the peritoneum be implicated in a mild attack of appendicitis, the lesions of this structure, particularly in the early stages, will also be mild. For this reason it can not be doubted that some at least of the severer forms of peritonitis, particularly the fibrinous (nonsuppurative) form, and even also some of the purulent variety, are initiated as a serous or sero-fibrinous inflammation. The peritonitis, however, in many of these cases, either because of the virulence of the irritant or its long-continued action, does not remain of this character, but speedily progresses to the fibrinous or purulent variety.

Serous or sero-fibrinous peritonitis is encountered in association with the milder forms of appendicitis only—acute catarrhal and mild interstitial appendicitis and the chronic forms of the disease with mild, acute exacerbations. Under such circumstances the peritoneum covering the appendix is in a state of inflammatory hyperemia. It is injected, many of the vessels being quite distended and visible to the unaided eye, while other minute ones, by their congestion, lend a diffuse redness to the tissue. In addition, the peritoneum has lost its normal luster, is slightly opaque, and is somewhat rough, velvety, or viscid to the touch. This latter characteristic is dependent upon the presence of a serous or sero-fibrinous exudate that, at times, is so slight as to be scarcely appreciable. Occasionally rupture of minute blood vessels occurs and leads to hemorrhagic foci. These alterations, as a rule, do not extend beyond the limits of the peritoneal covering of the appendix. Exceptionally, they may also implicate the meso-appendix, and more rarely the cecum, adjoining coils of intestine, and the parietal peritoneum. In certain isolated instances there may be in the neighborhood of the appendix a small collection of serous fluid.

Sonnenburg in particular believes in the occurrence of such serous peritonitis, and states that even large collections of serous exudate may be encountered. He records one case in which, at operation, he found a large exudate, consisting of turbid fluid free from bacteria, surrounded by a fibrous capsule, in the neighborhood of a chronically inflamed appendix. The occurrence of such circumscribed serous exudates is also spoken of by Roux, Lennander, Kümmel, Frankfurter, Renvers, and others. Sahli, commenting upon these cases, states that the possibility of their being either tuberculous or instances of polyarthritic (rheumatic) serous peritonitis can not be excluded. Nor can it be denied that some at least of them may have been originally sero-purulent, and in the course of time have become more serous and sterile as a consequence of the demise of the contained bacteria.

Fibrinous peritonitis is but an aggravation or further stage of the serous or sero-fibrinous variety of inflammation. It is found in association with acute catarrhal and interstitial appendicitis of moderate intensity, and with cases of chronic appendicitis in which there have been recurrences, the most recent one of some intensity. In some cases operated upon early in which the peritoneal lesions are of this variety it is quite likely, had the operation been deferred, that they would have progressed to suppuration, with or without perforation of the appendix.

In cases of fibrinous peritonitis the peritoneum in the region of the appendix is covered with a layer of fibrinous deposit of a grayish or grayish-yellow color and viscid to the touch. This is intimately adherent to the underlying peritoneum, and varies considerably in amount in different cases. At times it is excessively thin and watery, from the admixture of much serum and relatively little fibrin, and differs but little from the ordinary sero-fibrinous exudate. Again, there may be little serum and great amounts of fibrinous deposits. In the same case, also, the amount of fibrinous exudate may vary in different regions. Through the medium of this fibrinous or plastic exudate the appendix and the neighboring coils of intestine are more or less firmly united to each other and to the omentum and parietal peritoneum. After the separation of adherent coils of intestine the exudate may be stripped off in successive layers, revealing the peritoneum markedly congested, roughened, and lusterless. At times the exudate is so excessive that to locate the appendix requires more or less extensive dissection. Sometimes the appendix still eludes detection, and is found only after diligent search embedded in a dense amount of coagulated lymph that may surround it to an extent of from one to three centimeters.

Upon microscopic examination of the peritoneum in cases of serous, sero-fibrinous, or fibrinous peritonitis there are detected dilatation and overfilling of the blood vessels, proliferation of the endothelial cells lining the peritoneum, serous infiltration of the fibrous layer of the latter, and more or less round-cell infiltration. On the outer layer of the peritoneum there is a deposit of fibrin, which, of course, varies in amount in different cases. It commonly presents itself as a fine network that forms a support for the proliferating endothelial cells and wandering leukocytes. Occasionally, also, newly formed capillaries are detected. The cells of the network undergo various degrees of retrograde metamorphosis, and at times rupture of the newly formed capillaries ensues and gives rise to hemorrhagic foci. The serous fluid usually contains a few flocculi of coagulated lymph, and, even when quite clear, reveals microscopically a number of lymph corpuscles and desquamated endothelial cells.

In case this fibrinous peritonitis does not progress to suppuration, evidences of organization become manifest. The fibrinous network acts as a support for newly formed connective-tissue cells and capillaries. This granulation tissue, through the well known processes of regeneration, is transformed into fibrous connective tissue that speedily undergoes cicatrization. There thus results chronic peritoneal adhesions and bands, of which mention will be made subsequently.

CIRCUMSCRIBED PURULENT PERITONITIS, OR PERI-APPENDICULAR ABSCESS.

The most common peritoneal complication of acute appendicitis, and clinically the most important, because of its disastrous consequences, is circumscribed purulent peritonitis—the formerly so-called peri-typhlitic abscess. Just as a severe interstitial or ulcerative appendicitis may follow a catarrhal or a mild interstitial inflammation, so circumscribed purulent peritonitis may be an aggravation of a milder variety of peritoneal inflammation, and may follow in the sequence of a serous, a sero-fibrinous, or a fibrinous peritonitis. Thus, it is found in association with interstitial appendicitis without perforation, and with ulcerative appendicitis without perforation, and is always a concomitant of ulcerative appendicitis with perforation, unless the peritoneal involvement be diffuse. The peritonitis of gangrenous appendicitis is also of the purulent variety. Again, the acute infection or exacerbation of the inflammatory phenomena of a chronically inflamed appendix may be the starting-point of a circumscribed peri-appendicular abscess.

The serous and fibrinous exudates already described in connection with serous, sero-fibrinous, and fibrinous peritonitis are to be interpreted as the results of the reaction of the peritoneum to the action of an irritant—as an effort on the part of the peritoneum to protect itself from general infection. It thus subserves a useful purpose. More than this, in the event of perforation of the appendix—the perforation in the majority of cases occurring into, rather than outside of it—it has already formed a barrier that in most instances, for a time at least, prevents infection of the general peritoneal cavity. It is, however, not essential that perforation occur in order that an abscess result. An exudate originally fibrinous often becomes fibrino-purulent or purulent without perforation of the appendix developing.

In circumscribed purulent peritonitis, or peri-appendicular abscess, a greater or smaller portion of the peritoneal cavity lodges a focus of suppuration that develops at the site of the original source of infection and is walled off from the general peritoneal cavity by more or less firm fibrino-plastic exudate. This peri-appendicular abscess may develop slowly or exceedingly rapidly, and in different cases it varies much in size and in other characteristics. There may not be more than one or two cubic centimeters of pus, in which case the abscess may be difficult to locate; on the other hand, the abscess may be exceedingly large, and may contain upward of a liter of pus. Usually, however, in an unprotected case there is not more than thirty cubic centimeters of pus. The abscess may be single or multiple, and may be regular or irregular in outline. It is not rare to find several pockets of pus that communicate with a common cavity. Under other circumstances several isolated pockets may communicate with one another by narrow and tortuous channels.

The wall of the abscess cavity is made up of a grayish-yellow or yellowish-green discolored fibrino-purulent exudate. This is of variable firmness and consistency, and serves to more or less securely unite the appendix, cecum, neighboring coils of intestine, omentum, mesentery, and parietal peritoneum. The pus is sometimes yellowish in color and distinctly creamy in appearance. More commonly, however, it is thinner than cream, of a yellowish-green, brownish, or greenish-black color. Sometimes it is bluish or greenish in color, and may under such circumstances reveal the bacillus pyocyaneus in pure culture. It usually possesses a peculiar, penetrating, disagreeable, fecal odor. At times it is distinctly putrid, and may contain gas, the latter the result of the activities of contained bacteria or from admixture of intestinal gases in cases of perforation. In addition to the pus, the abscess may contain more or less necrotic remnants of fibrinous exudate, one or more fecal concretions, and some fecal matter. In it also we may detect the more or less altered appendix. The appendix, in whole or in part, may appear suspended, as it were, in the abscess cavity, or it may have become entirely separated from its cecal attachment by circular amputation, and may float entirely free in the pus. More commonly it will be found embedded in the exudate forming part of the limiting wall of the abscess.

The situation of the abscess varies greatly in different cases, and is naturally dependent to a considerable extent upon the situation, the direction, the length, the mobility, and the possible fixation of the appendix. In exceptional cases the appendix and the cecum are found in anomalous positions, which in the event of appendicitis, exert considerable influence in determining the situation of possible peri-appendicular suppuration. In the majority of cases, however, it is possible to divide these abscesses, with respect to their situation, into certain groups, of which Sonnenburg distinguishes four that are of common occurrence: (1) Anteriorly; (2) posteriorly; (3) medianly; (4) in the pelvis. In the first, according to him, there at first occurs an adhesion of the coils of intestine that normally are almost always found in front of the cecum. Beneath these the abscess originates. As it increases in size, the adherent coils of intestine are displaced and the pus reaches the parietal peritoneum. The latter thus forms the anterior boundary of the abscess, the cecum the posterior and median boundary, and the iliac fossa the outer boundary. In addition, various coils of intestine may assist in the limitation of the abscess above. In these cases the appendix is usually found anteriorly in the iliac fossa or attached to the outer or lower surface of the cecum. When situated posteriorly, the abscess is limited anteriorly by the posterior surface of the cecum, and posteriorly by the posterior abdominal wall. In these cases the appendix is usually attached to the posterior surface of the cecum and is directed upward. These abscesses are situated higher than those of the former group, and, spreading out in the region of the kidney, they may give rise to perirenal suppuration; or, reaching the lumbar region, they may cause protrusion of it. Abscesses situated medianly are bounded laterally or externally by the median aspect of the cecum and ascending colon; posteriorly, by the meso-colon; median, anteriorly, and above, by various coils of intestine. Attaining a considerable size, these abscesses may reach to, and be limited by, the bladder. Abscesses situated in the pelvis commonly occupy the right half of it, though they frequently extend also to the left. They are often situated in the retrovesical space,—in women, in Douglas' culdesac. The appendix is usually detected in the upper and outer wall of the abscess; frequently, however, it may be adherent to the bladder, uterus, tubes, ovary, rectum, etc. This classification had been adopted independently by Deaver, who, in addition to describing the foregoing four varieties of peri-appendicular abscess, is in the habit of speaking of a fifth variety—the diffuse abscess, or diffuse purulent peritonitis. As already intimated, these peri-appendicular abscesses may be encountered in most unusual situations. Of such may be mentioned: Near the gall-bladder, near the spleen, in the region of the umbilicus, beneath the right lobe of the liver, beneath the diaphragm, in the left iliac fossa, in a hernia,—inguinal or femoral, of either the right or left side,—etc.

Heretofore mention has been made only of the suppurative complications of appendicitis that occur within the peritoneal cavity—to circumscribed appendicular peritonitis. It must, nevertheless, be stated that, in the event of suppuration ensuing upon an attack of appendicitis, it is not necessary that the collection of pus be situated primarily within the peritoneal cavity. The abscess may be retroperitoneal—the formerly so-called *para-typhlitic abscess*. This may be due to one of several causes: (1) It may occur if the appendix be situated retroperitoneally, as happens, as has been mentioned already, in about two per cent. of the cases. In case infectious material penetrate the wall of the appendix, or if perforation of the organ occur, the retroperitoneal connective tissues are those first attacked, and a retroperitoneal abscess results. (2) Such may also develop, although the appendix be situated intraperitoneally, if the perforation occur into the meso-appendix. Under such circumstances the liberated infectious material dissects its way between the two layers of the meso-appendix, and finally reaches the retroperitoneal connective tissues, where the abscess originates. It is quite likely also, that, in the absence of perforation, some retroperitoneal abscesses may be produced by virulent infectious material being carried by the lymphatics of the meso-appendix to the retroperitoneal connective tissues. (3) Such retroperitoneal suppuration may also occur in some cases in which rather firm adhesions bind the appendix to the posterior layer of the peritoneum. In these cases this posterior layer of the peritoneum may have become so altered by the inflammation that, in the event of perforation, it offers but little resistance to the advances of virulent bacteria and their toxins. Being less resistant than the firm adhesions, it gives way first, and there thus occurs a perforation of the appendix, directly through its peritoneal coat, some adhesions, and the posterior layer of the peritoneum, into the retroperitoneal connective tissues. A retroperitoneal abscess results, without any associated intraperitoneal suppuration. (4) Retroperitoneal abscesses may occur secondarily by perforation through the posterior layer of the peritoneum of an abscess that originated intraperitoneally.

Such retroperitoneal abscesses sometimes give rise to the most extensive phlegmonous infiltration. Following the course of the iliac vessels, they may present themselves beneath Poupart's ligament; they may involve the region of the kidney and engender a large perirenal abscess, with or without implication of the kidney; they may ascend behind the liver and spread out over its surface, producing an extensive subdiaphragmatic abscess; they may perforate into the pleura and produce an empyema; they may penetrate the lung and give rise to a pulmonary abscess, that may or may not be expectorated externally; they may perforate again into the peritoneal cavity; etc.

Reverting again to peri-appendicular abscess situated primarily within the peritoneal cavity, it will be recalled that it was stated that it may attain a capacity of a liter. Such an occurrence, however, is most exceptional. Usually, if the abscess be progressive, before it has attained such a size one of several events will have ensued. There will either have been produced a general peritonitis,—of which mention will be made later,—or, if the adhesions be sufficiently firm to protect the general peritoneal cavity from infection, the abscess will probably have ruptured in one of several directions. As the abscess increases in size it not only compresses the adjacent organs and tissues, but the latter themselves become the seat of more or less superficial or deep inflammation with purulent infiltration and necrosis. The various organs and tissues of the region of the appendix permit of a certain amount of compression without much resentment, but when the limit has

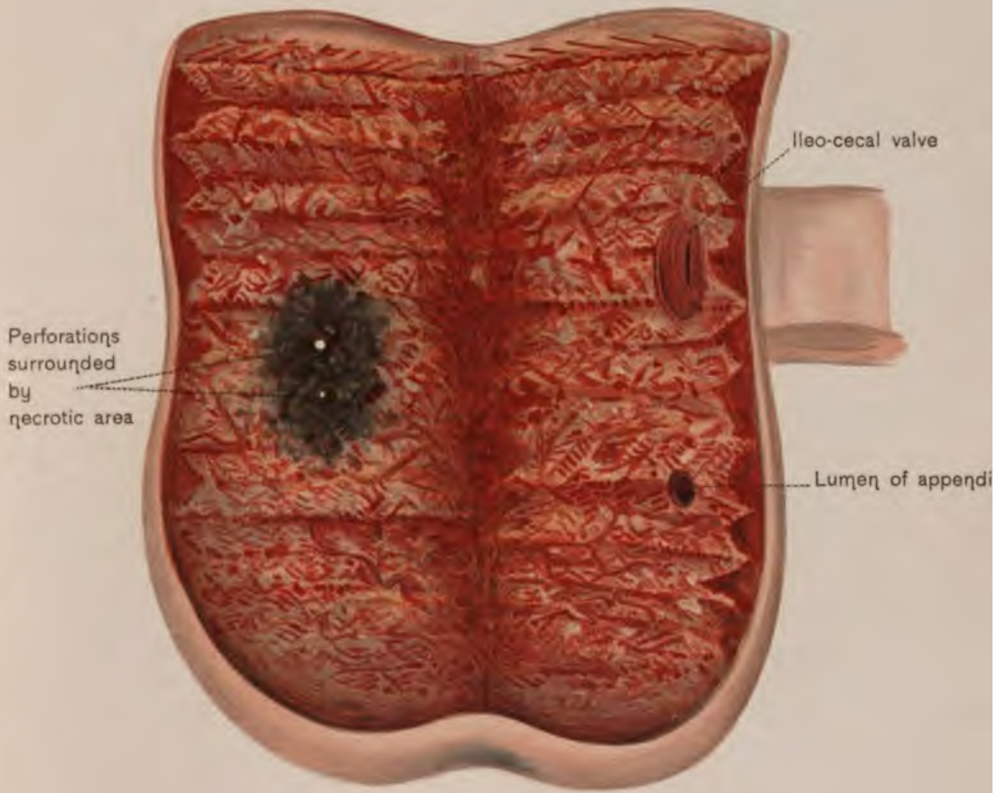
ACUTE APPENDICITIS WITH PERI-APPENDICULAR ABSCESS RUPTURED INTO THE CECUM.—H. W., twenty-five years, was admitted to the German Hospital on January 15, 1896. Ten days prior to admission, after eating, he was suddenly attacked with acute pain in the right iliac fossa, which was followed by tenderness and marked rigidity. There was neither nausea nor vomiting. He remained in bed two days. The symptoms abated, but pain, which was increased on motion, persisted in the right iliac region. At the time of admission to the hospital there were tenderness on pressure over McBurney's point and rigidity of the right lower abdominal wall, and on palpation a mass could be felt in the right iliac fossa. The tongue was coated and the temperature was normal.

At operation the appendix was found situated throughout almost its entire length in front of the cecum. It was curled about the cecum, however, and its tip was adherent to the posterior surface of that viscus. It was covered by dense adhesions, upon loosening which about one pint of thick, fetid pus escaped from behind the cecum. The pus cavity was wiped with dry gauze (no irrigation); the appendix was freed and excised; gauze drainage was inserted and the wound was closed.

For sixteen hours after the operation the patient did well and suffered little. Suddenly he had a sharp accession of pain in the epigastric region, was nauseated, and finally began to vomit greenish matter in which some blood was discernible. There was slight abdominal distention. The wound was dressed, the gauze was removed, and the cavity was cleansed. Delirium set in, vomiting became continuous, and death ensued on the third day after the operation.

At the necropsy the incision was found closed and in good condition. In the upper posterior portion of the cecum there was a large area of necrosis, in which were two small perforation ulcers, which were most extensive on the serous surface of the cecum. There had occurred, from without inward, necrosis and perforation of the cecum. The cicatrix at the site of the amputation of the appendix was scarcely discernible.

PLATE X



Internal aspect of a cecum illustrating a necrotic area and two perforations—acute appendicitis with peri-appendicular abscess ruptured into the cecum.

been reached, the abscess of necessity ruptures in the direction of least resistance. As some of the organs of this region, because of their implication in the inflammation, are themselves the points of least resistance, it is into them that rupture often occurs. Certain organs, however, are much more likely to be the seat of such perforation than others. The relative frequency of perforations into different tissues and organs is indicated by Sonnenburg, who cites the reports of various observers. These include a total of 424 cases, the combined statistics of Bull, Langheld, Einhorn, Krafft, and Paulier. Collectively, the most frequent perforations were as follows:

Through the abdominal wall,	46
Into the cecum,	40
" peritoneal cavity,	8
" pleural cavity,	6
" ascending colon,	4
" rectum,	4
" ileum,	3
" bladder,	3
" uterus,	1

It was misconception of the real direction of the perforation in certain cases of peri-appendicular abscess that, in part at least, led to the erroneous view maintained some years ago, that appendicitis was typhlitis, peri-typhlitis, and para-typhlitis, and that the suppurative forms of the latter were the result of perforation of the cecum. Suppurative disease about the cecum did not, as was then held, result from disease and perforation of the cecum. On the contrary, perforation of the cecum, in many of these cases, was due to rupture into the cecum of an already formed peri-appendicular abscess (Plate XX); in other cases it was due to a direct rupture of the appendix into the cecum, with which it had formed adhesions (Plates V and XXI). There occur, however, cases of perforation of the cecum due to some morbid condition of that viscus, such as large enteroliths, etc.

In addition to the previously detailed directions of rupture of peri-appendicular abscesses, rare instances of perforation into other organs have been encountered. Thus, cases have been reported in which the abscess ruptured into the gall-bladder, into the duodenum, into the vagina, into the ureter (pelvis of

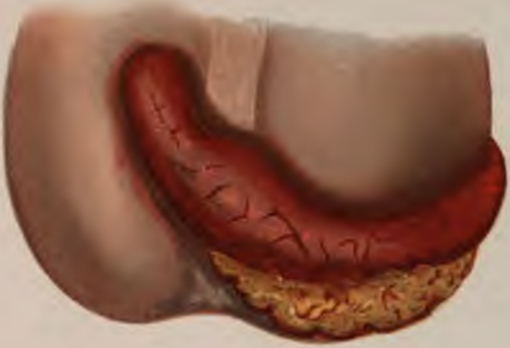
CHRONIC APPENDICITIS WITH ACUTE EXACERBATION—ACUTE ULCERATIVE APPENDICITIS WITH PERFORATION DIRECTLY INTO THE CECUM.—The following case was that of the wife of a physician, who has kindly furnished me the subjoined history:

Mrs. H., early in April, 1895, had several attacks of abdominal pain accompanied by diarrhea, but they were not considered of any importance. On April 28th another severe attack came on suddenly at 2 A. M. At 10 A. M. she had excruciating pain, which, though general throughout her abdomen, was particularly severe in the region of the navel and the right iliac fossa. The pain finally became localized in the right side, and was accompanied by extreme tenderness, nausea, vomiting, and diarrhea. A hypodermic injection of morphin and repeated small doses of calomel were administered, and hot poultices were applied locally. The abdomen soon became distended, the pain and tenderness increased, and on palpation thickening and induration were detected. Appendicitis was diagnosed. A consultation was held with reference to the advisability of operation. This was not concurred in, as the consultant considered that the case was not one of appendicitis, but ordinary catarrh of the intestines. The poultices were continued and the morphin was stopped, and calomel was administered on account of constipation which had followed the original diarrhea. For the first week there was little change in her symptoms. After the first week improvement commenced, but upon the slightest touch there was marked tenderness, and the induration remained. Four weeks from the time of the last attack her condition was fair, but, upon other advice, operation was decided upon.

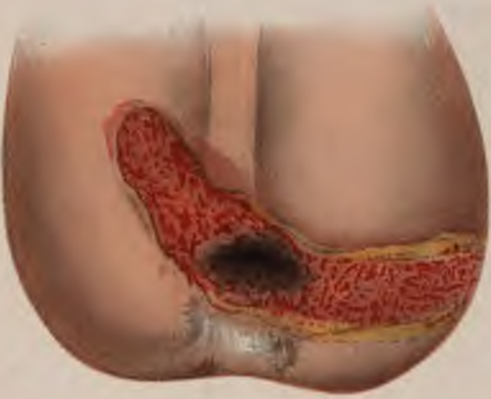
At operation the parietal peritoneum was not adherent. There was a mass of omentum adherent to the cecum, which was deeply congested and infiltrated, resembling in appearance a cock's comb. The adherent omentum was freed, ligated, and removed. The cecum was exposed, and revealed behind it a small collection of foul pus. The appendix was adherent to the cecum. It was detached, ligated, and removed, whereupon a perforation was seen in both the cecum and the appendix, permitting of the discharge into the cecum of the appendicular contents. The margins of the perforation in the cecum were freshened and sutured. Gauze drainage was employed.

Recovery, though delayed by a stitch abscess, was eventually complete.

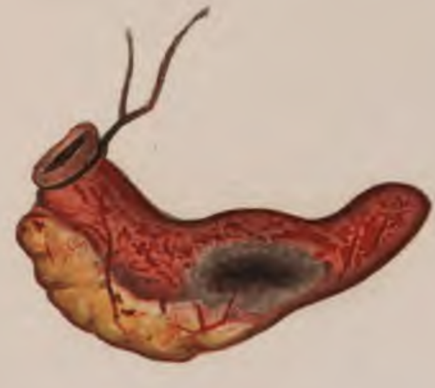
PLATE XXI



Appendix adherent to cecum



Appendix dissected off showing perforation into cecum



Perforation upon detached surface of appendix

Chronic appendicitis with acute exacerbation—acute ulcerative appendicitis with perforation directly into the cecum.

the kidney), etc.; and Sonnenburg mentions a case in which, through infection of a probable patulous vaginal tunic of the testicle, there resulted a pyocele of the testicle.

But other secondary disastrous consequences ensue upon the persistence of the abscess. Thus, there may occur lymphangitis and lymphadenitis, thrombo-phlebitis and pylephlebitis. The thrombo-phlebitis usually affects the mesentery and portal veins, but thrombosis of the iliac and femoral veins of either the right or the left side, or of both, may develop. The pylephlebitis is sometimes of the mild or noninfectious variety,—the so-called adhesive pylephlebitis,—in which the thrombus leads to partial or complete obliteration of the portal vein. Frequently, however, the process is infectious; the thrombus becomes purulent, and leads first to abscess of the liver, and subsequently to general infection, or pyemia. Again, erosion of a principal branch of the mesenteric vein has been encountered (Aufrecht), and implication of a branch of the inferior vena cava, with consecutive pulmonary abscesses, is not unknown. Of other conditions secondary to the abscess may be mentioned: Erosion of the internal iliac artery or of one of its branches; iliopsoitis; perihepatitis; suppurative pleuritis; endocarditis; parotitis; meningitis; abscess of the kidney, spleen, etc.; disease of the female genitalia; and general septicemia, pyemia, etc.

It can not be denied, however, that, under exceptional circumstances, absorption of pus may occur. This is, nevertheless, a very rare event, and ensues only when the abscess is very small and the virulence of the contained bacteria very slight. Under such circumstances the abscess gradually becomes sterile, then inspissated, and there may result the formation of a thick mass of indurative connective tissue, which rarely has been found the seat of calcareous infiltration. Under other circumstances the abscess may remain fluid and encysted —surrounded by a firm connective-tissue capsule.

Of recent years, as the nature of appendicitis is becoming more thoroughly appreciated, and the appropriate treatment more generally undertaken, the previously detailed disastrous complications are becoming progressively less. The more universal become the early recognition and the prompt surgical evacuation of appendicular and peri-appendicular suppuration or the removal of the diseased appendix before the supervention of suppuration, the less frequent are the secondary results of such collections of pus. It is for this reason that they whose practice it is to operate early in cases of appendicitis do not meet with these complications so frequently as do they who delay operation.

DIFFUSE OR GENERALIZED PERITONITIS.

In diffuse or generalized peritonitis the entire, or almost the entire, visceral and parietal peritoneum are involved in the inflammatory processes. Such peritonitis may develop in a variety of ways, and its pathologic anatomy differs considerably in different cases. It is found associated with severe cases of acute interstitial appendicitis without perforation, with ulcerative appendicitis with or without perforation, and with gangrene of the appendix. Several types of diffuse or generalized peritonitis may be distinguished, and a classification may be based not only upon the character of the pathologic alterations, but also upon the manner of their production.

Thus, there is a form that may develop by gradual progression from a circumscribed purulent peritonitis—the *progressive fibrino-purulent peritonitis* of Mikulicz. This variety of general peritonitis is the slowest of all forms in its diffusion. From the original focus of infection, which may be a peri-appendicular abscess or a small perforation,—the perforation occurring at a time when limiting adhesions have not yet formed,—the entire peritoneum, step by step, as it were, becomes implicated. As this occurs, each new portion that is affected becomes walled off from the remaining unaffected peritoneum by more or less firm adhesions, in a manner similar to that which limits the original infectious focus or surrounds the appendix before it has perforated. These adhesions, which may unite portions of the intestine and omentum with any of the abdominal organs or with the parietal peritoneum, thus serve to protect the remaining peritoneum from sudden infection. These adhesions, in the majority of instances, are at first purely fibrinous in nature. However, they speedily become fibrino-purulent and purulent, and there are thus formed, in various portions of the peritoneum, pockets of pus that are more or less separated from one another. Some of them are entirely isolated, but many of them may communicate with one another by more or less tortuous channels. Gradual leakage of the infectious material occurs, additional portions of the peritoneum are involved, new adhesions (limiting barriers) are formed, new foci of suppuration develop, until finally the entire peritoneum may become implicated. It is rather uncommon to find that the entire peritoneum is involved; there usually remain larger or smaller areas that seem to have resisted the onslaughts of the infection, and these are always separated from the affected peritoneum by the fibrinous wall. Careful search is sometimes necessary not only to detect these unaffected regions, but also to determine the situation of some of the pockets of pus.

In another series of cases there occurs a *diffuse* or *generalized purulent* or *suppurative peritonitis* without noteworthy fibrinous exudate, and consequently with but slight and friable adhesions between the coils of intestine, omentum, abdominal organs, and parietal peritoneum. Such peritonitis develops when perforation of the appendix occurs suddenly and soon after the onset of the disease,—at a time when the peritoneum has not yet had time to form a plastic exudate; when a large and ill circumscribed empyema of the appendix suddenly bursts; when there occurs a sudden gangrene of an appendix that is not well surrounded by adhesions; and when, for any reason, the adhesions limiting a peri-appendicular abscess suddenly give way and liberate a large quantity of pus. Thus, the peritoneal adhesions vary somewhat, depending upon whether the ulcerative processes in the appendix, and consequently the perforation, develop slowly or rapidly. If the former, the peritoneum has had time to form a greater or less amount of plastic exudate that completely surrounds the appendix, and, in the event of perforation, there results a circumscribed peritonitis or abscess, as has already been detailed. If the perforation develop suddenly, the appendicular contents are poured forth into the free peritoneal cavity. The intensity of the resultant inflammatory lesions depends upon the amount, the fluidity, the virulence, and the rapidity of the evacuation of the appendicular contents. These, having gained access to the general peritoneal cavity, are rapidly dispersed through extensive portions of the peritoneum by the peristaltic action of the intestines, and a diffuse purulent peritonitis ensues.

In this variety of inflammation the peritoneum is the seat of an intense inflammatory hyperemia; it is opaque and lusterless, and is covered with a small amount of a grayish-yellow or yellowish-green, veil-like, slimy, viscid exudate. These lesions, as a rule, are not distributed with unformity throughout the peritoneum, but are commonly more marked near the seat of infection. It is not unusual, however, to find them affecting the peritoneum of the small and large intestines, the omentum, the mesentery, the solid abdominal organs, and the abdominal wall. The slight amount of exudate may serve loosely to unite neighboring loops of intestine, but, as a rule, there are no firm adhesions unless they be old. The exudate, being attached loosely, often appears as a shredded covering of the intestine, and the unattached ends of the shreds can frequently be detected floating upon the surface of the pus contained within the peritoneal cavity. At times these shreds become entirely detached from the intestine and float free in the pus. The pus varies considerably in different cases. At times there is relatively little; again, the amount is excessive—a liter or more, and this within a short time of the onset of the attack. For a time, at least, it is freely movable, and, following the laws of gravity, seeks the dependent portions of the peritoneal cavity—recesses between adjoining coils of intestine, the pelvis, and the prerenal regions. Later, if some adhesions are formed, there may occur more or less circumscribed collections of pus in various other regions. In character the pus is rarely thick and creamy; it is usually rather thin, limpid, of a greenish-yellow color, at times of a brownish tint, and of a distinctly fecal odor.

At times this variety of peritonitis assumes markedly putrid characteristics—*putrid peritonitis*. The peritoneum is swollen, congested, softened, and of a turbid grayish or grayish-red, opaque color. The exudate is usually rather small in amount, of a turbid grayish, grayish-red, or grayish-brown color, and exceedingly malodorous. At times it may contain gas, even in the absence of perforation of the appendix. This is of most unusual occurrence; but despite the prevailing differences of opinion, it can not be denied that certain gas-forming bacteria may penetrate the diseased wall of the appendix and give rise to the formation of gas in the peritoneal cavity, even in the absence of perforation of the appendix. As a matter of fact, however, this variety of peritonitis is usually found in association with gangrene of the appendix with perforation. As a consequence, the production of gas is readily explicable, as is also the fact that at times portions of the gangrenous appendix, a fecal concretion, or, rarely, a foreign body can be detected free in the peritoneal pus.

Under other circumstances the peritonitis assumes a hemorrhagic character—*hemorrhagic peritonitis*. The peritoneum is excessively congested and the seat of more or less extensive hemorrhagic suffusions. There is also some admixture of blood with the purulent or sero-purulent exudate, which gives it a reddish or brownish color. Otherwise the lesions do not differ from those already detailed.

The last-named varieties of peritonitis are closely allied to that even more rapidly fatal form known as *septic peritonitis*, or *peritoneal sepsis*. In view of the fact, however, that the symptoms and pathologic lesions of none of the varieties of peritonitis are unassociated with the activities of bacteria, the reservation of the term septic—a term variously interpreted at present—to designate a certain class of inflammations of the peritoneum is open to objection. As the clinical and pathologic features of this variety of peritonitis are due to the rapid absorption of a large quantity of virulent toxins, it may be preferable to designate it *toxic peritonitis*. Clinically, the predominating characteristics of this variety are not alone the evidences of disease of the peritoneum, but also, and particularly, the indications of profound intoxication, which, as is well known, manifest themselves principally by disturbances of the nervous system and of the general economy. Pathologically, cases of this class differ from those of the other classes by the relative meagerness of the lesions. In the other varieties of peritonitis the peritoneum is able to offer some resistance to the spread of the infection, and this resistance is manifest by the evidences of inflammation and the attempts at restriction of the infectious focus to a portion of the peritoneum. In cases of toxic peritonitis, however, the peritoneum, and secondarily the general economy, are suddenly overwhelmed with such a quantity of virulent toxins that the patient may succumb before the peritoneum is able even partly to recover itself and to attempt an adequate resistance.

The lesions detected in these cases are often inconspicuous. Aside from injection of the peritoneum, either in whole or in part, there may be no deviations from the normal. In other cases the congestion may be more intense and wide-spread, and there may be minute hemorrhages beneath the serosa; in addition, the peritoneum may be a little less glistening than normal, and there may be a slight amount of free fluid. The latter is usually small in amount, thin, limpid, and of a yellowish-green color and somewhat malodorous. At times the peritoneum is quite dry. There may also be a diffuse, infectious, serous peritonitis, as described by Tietze, but personally the author has never encountered an instance of this. Under other circumstances portions of the peritoneum may be distended, whereas others may preserve their normal caliber. Here and there a few fibrinous flakes may be seen, but firm adhesions are never encountered; the spleen is enlarged and there is cloudy swelling of the liver, kidneys, heart muscle, etc.

CHRONIC APPENDICULAR PERITONITIS.

If an attack of sero-fibrinous or fibrinous peritonitis complicating appendicitis take a favorable course,—that is, do not go on to suppuration,—or if the appendix be not removed by operation, the exudate, as has already been intimated, undergoes the ordinary alterations characteristic of the formation of fibrous tissue. There thus result bands of adhesions that unite the appendix, portions of intestine, omentum, mesentery, and parietal peritoneum. The longer the affection of the appendix has continued, the more numerous and severe have been the recurrences, the more certain are peritoneal adhesions to be found, and the more firm and extensive are they likely to be. After the removal of the diseased appendix by operation the remaining exudate always tends to organization and cicatrization.

The macroscopic appearances in cases of chronic peritonitis vary somewhat, depending upon whether the examination be made during a recurrence or during the interval between attacks. Generally, however, the appendicular peritoneum—usually, also, that of the meso-appendix—is congested, thickened, opaque, and harder than normal. The appendix is more or less firmly united to the cecum, colon, omentum, intestine, mesentery, parietal peritoneum, or some of the viscera by means of bands of adhesions that vary much in thickness and firmness. They may be slight, long, much attenuated, and readily broken, or they may be short, very thick, and exceedingly dense and fibrous. Not only is the appendix often united to the structures just enumerated, but the latter are themselves frequently firmly united with one another. A portion of the omentum, the appendix, and a loop of intestine may, with adhesions, form so dense a mass that only careful search reveals the situation of the appendix, and the most painstaking dissection is requisite to remove it. This may also be true of the cecum and of other portions of the intestine, which are often bound down, twisted, constricted, and dislocated by bands of adhesions of various characteristics.

The associations that the appendix forms with other organs by the medium of these bands naturally depend upon its situation, and this, in certain cases, is not independent of the great mobility of the organ. In its ordinary situation the appendix is, of course, most frequently united with the cecum; then, in order of frequency, the peritoneum of the right iliac fossa, the mesentery, the small intestine (ileum), the omentum, and the colon. In women it is often adherent to the right uterine adnexa. When in unusual situations, or when excessively long and motile, the appendix may have formed adhesions with almost any of the intraperitoneal organs—the duodenum, gall-bladder, liver, spleen, ureter, bladder, rectum, left uterine adnexa, etc.

These adhesions are of varying importance. If they be small, of slight extent, and yielding, they may be devoid of portentous significance. On the other hand, they are commonly distinctly detrimental to health. They contribute to renewed attacks of appendicitis by restricting the free motion and the peristaltic action of the appendix, and by causing compression, strictures, twists, angulations, etc., of the organ. In addition, they often engender the most disastrous intestinal conditions. By their mere adhesion to portions of the bowel they inhibit peristalsis, and by their contraction they may, by compressing or encircling the bowel, cause intestinal obstruction, angulation, or strangulation. They may also compress the ureter and give rise to hydronephrosis and pyonephrosis, and produce a variety of clinical manifestations by reason of their connection with the liver, spleen, bladder, ovary, etc. On the contrary, they are not altogether without value. Contributing, as they do, to recurrences of appendicitis, in the event of such developing and perforation ensuing they have formed a barrier that, for a time at least, effectually prevents infection of the general peritoneal cavity. Theoretically, at least,—especially if they surround the appendix or bind it to the wall of the pelvis,—as they contract they assist in the constriction and obliteration of the lumen of the organ. If the latter occur, the likelihood of recurrence of the inflammation is excluded.

The frequency of these adhesions is indicated by the statistics of Leichtenstern, who found, among 1541 cases of intestinal obstruction, 34 resulting from disease of the appendix.

THE BACTERIOLOGY.

As the basis of a discussion of the pathogenetic rôle of bacteria in appendicitis the results of the bacteriologic investigations of 286 appendices removed by operation may be detailed. The first inoculation in each case was made from the lumen of the appendix after aseptic incision of its wall, and the inoculation was always made from the seat of most manifest disease. At times inoculations were also made from the exudate on the peritoneal surface of the appendix, from pus of the abscess, from free pus in the peritoneal cavity, and from drainage fluid subsequent to the operation. The results of these later inoculations in no case differed from those of the primary inoculations from the lumen of the appendix. Inoculations in the first place were made into bouillon or into agar tubes, or both. Subsequently, in many of the cases, Petri-dish cultures were made, and later various other inoculations, for the purpose of fully establishing the identity of the bacteria under investigation. In some instances, also, cover-slip preparations were made directly from the pus or other contents of the lumen of the appendices, from the exudate on the peritoneal surface, or of the free pus. Of the 286 appendices examined bacteriologically, 128 were instances of acute appendicitis; 158 of chronic appendicitis. The results of the examinations may be tabulated as follows:

Acute appendicitis:

Bacterium coli commune alone, . . .	93	cases	(72.656	per cent.).
Bacterium coli commune and staphylococcus pyogenes aureus, ...	17	"	(13.28	"
Bacterium coli commune and streptococcus pyogenes, ...	6	"	(4.69	"
Bacillus pyocyaneus alone, ...	6	"	(4.69	"
Staphylococcus pyogenes albus alone,	3	"	(2.344	"
Staphylococcus pyogenes aureus alone,	1	case	(0.78	"
Bacterium coli commune and staphylococcus pyogenes citreus, ...	1	"	(0.78	"
No growth, ...	1	"	(0.78	"
Total, ...	128	cases	(100.00	per cent.).

Specifically, the results of the bacteriologic examinations with reference to the various forms of acute appendicitis were as follows:

Acute catarrhal appendicitis:

Bacterium coli commune alone, ...	4 cases.
Bacterium coli commune and staphylococcus pyogenes aureus, ...	1 case.
Total, ...	5 cases.

Acute interstitial appendicitis:

Bacterium coli commune alone, ...	15 cases.
Bacterium coli commune and staphylococcus pyogenes aureus, ...	6 "
Bacillus pyocyaneus alone, ...	2 "
Total, ...	23 cases.

Acute ulcerative appendicitis without perforation:

Bacterium coli commune alone, ...	39 cases.
Bacterium coli commune and staphylococcus pyogenes aureus, ...	3 "
Bacterium coli commune and streptococcus pyogenes, .	3 "
Bacillus pyocyaneus alone, ...	3 "
Staphylococcus pyogenes aureus alone, ...	1 case.
Total, ...	49 cases.

Acute ulcerative appendicitis with perforation:

Bacterium coli commune alone, ...	24 cases.
Bacterium coli commune and staphylococcus pyogenes aureus, ...	5 "
Staphylococcus pyogenes albus alone, ...	3 "
Bacterium coli commune and streptococcus pyogenes, .	1 case.
Bacterium coli commune and staphylococcus pyogenes citreus, ...	1 "
Total, ...	34 cases.

Gangrenous appendicitis:

Bacterium coli commune alone, ...	11 cases.
Bacterium coli commune and staphylococcus pyogenes aureus, ...	2 "
Bacterium coli commune and streptococcus pyogenes, .	2 "
Bacillus pyocyaneus alone, ...	1 case.
No growth, ...	1 "
Total, ...	17 cases.

The following were the results of the bacteriologic examinations in the cases of chronic appendicitis:

Bacterium coli commune alone, . . .	142 cases	(89.873 per cent.).
Bacterium coli commune and staphylococcus pyogenes aureus, ...	7 "	(4.43 "
Bacillus pyocyaneus alone, ...	2 "	(1.266 "
Bacterium coli commune, staphylococcus pyogenes aureus, and staphylococcus pyogenes albus, ...	1 case	(0.633 "
Staphylococcus pyogenes aureus alone,	1 "	(0.633 "
Bacterium coli commune and bacillus prodigiosus, ...	1 "	(0.633 "
No growth, ...	4 cases	(2.532 "
Total, ...	158 cases	(100.00 per cent.).

From the foregoing, therefore, it is evident that the bacterium coli commune was found alone in 72.65 per cent. of the acute cases and in 89.873 per cent. of the chronic cases; that it was found either alone or in combination with other bacteria in 117 (91.4 per cent.) of the acute cases and in 151 (96.2 per cent.) of the chronic cases. Although these facts are extremely suggestive, the relation of the bacterium coli commune to the development of appendicitis and consecutive peritonitis is not the simple one that it at first sight appears.

It is not many years since the bacterium coli commune was looked upon merely as an innocuous inhabitant of the intestine—as an organism devoid of pathogenetic properties. Its detection in pure culture, however, in many cases of peritonitis, as well as in morbid conditions of other intra-abdominal organs, directed attention to the possibility of it possessing pathogenetic attributes. Finally, the determination that the bacterium coli commune isolated from the intestine in case of disease of that structure is more virulent than that secured from the normal intestine, and the experimental production of peritonitis by the introduction of cultures of this organism into the peritoneal cavity of lower animals, definitely proved its pathogenetic properties.

Investigations of recent years conclusively demonstrated not only that the bacterium coli commune is variable in pathogenetic properties,—that is, in virulence,—but also that it exhibits other biologic and morphologic differences, such as of size, shape, motility, etc. It suffices to mention that its variation in size is well known; that some cultures are much more actively motile than others; that Adami has recently described a diplococcus form; and that the organisms described as the bacillus pyogenes fœtidus (Passet), the bacillus lactis ærogenes (Escherich), the bacillus neapolitanus (Emmerich), the bacillus enteritidis (Gärtner), the pyogenic urinary bacillus of Clado and Albarran, etc., are most likely but varieties of a class of bacteria most appropriately designated the "colon group." These exhibit quantitative differences in their biologic characteristics, but it is questionable if they do so to a degree sufficient to warrant their separation into distinct species.

When the bacterium coli commune was found in the peritoneal cavity, and in the exudate upon the serous coat of the intestine, in the absence of perforation of that structure,—as, for instance, in so-called idiopathic peritonitis, strangulated hernia, volvulus, etc.,—the relations of this organism to the intestinal wall and vice versâ demanded study. That which particularly required elucidation was the question whether this micro-organism possesses the power to penetrate the wall of the intestine. As a consequence of investigation it has been determined that this bacterium does possess the power to penetrate the wall of the intestine, although the normal intestine, particularly its mucous membrane, opposes effectually a barrier to the bacterium of ordinary virulence. If, however, the bowel be reduced in resistance,—as occurs in congestions, inflammations, etc.,—the bacterium penetrates the wall with more or less facility. It is most certain, also, that the toxin elaborated by virulent bacteria coli commune retained within a restricted portion of the bowel may so alter the mucous membrane as to permit of invasion of the wall. This, without a doubt, occurs in such an anatomic tube as the appendix.

We have thus come to view the bacterium coli commune as a group of bacteria rather than as a single species. The individual species have been described under a variety of names, and exhibit quantitative differences in their biologic properties. These bacteria are normal in all portions of the intestinal tract where they appear a few hours after birth. They are probably directly or indirectly concerned in the processes of digestion. Ordinarily, they are but slightly virulent, or they may be innocuous. Under a variety of circumstances, however, they become greatly increased in virulence, and their toxin may acquire very high potentiality. This augmentation of virulence occurs in a number of diseased states, such as obstruction, strangulation, volvulus, congestion, edema, and inflammation of the bowel; in various diarrheic conditions, such as that which follows the administration of purgatives, typhoid fever, cholera, etc.; and in marked and long-continued constipation. This heightened virulence may be due to the association with the bacterium coli commune of other bacteria, but under some circumstances it seems to be due to alterations of the bowel alone.

That the bacterium coli commune is not the only microorganism concerned in the pathogenesis of appendicitis is sufficiently evident from the foregoing statistics and from the investigations of other observers. Tavel and Lanz first directed attention to the frequent implication of several forms of bacteria in the production of appendicitis, and these authors were soon followed by Barbacci, and since then by others, among whom may be mentioned Welch and others in this country. It has been contended by these observers that appendicitis is the consequence of a mixed infection; that it rarely results from a monoinfection. The fact that the bacterium coli commune alone is usually isolated from cultures of the pus from cases of appendicits is explained by stating that the bacterium coli commune proliferates much more luxuriantly than do the other bacteria present, and thus outgrows them.

In but 33 of the author's 286 cases was such mixed infection demonstrated by the methods of investigation pursued. These comprised 24 acute cases (18.75 per cent.) and 9 chronic cases (5.7 per cent.). It should be mentioned here that those instances in which cover-slip preparations of the contents of the appendix and of the peri-appendicular exudate and pus were examined the results of the examination did not differ from the results obtained by culture methods. Cocci, in particular, were conspicuous by their absence. In this respect my own investigations are somewhat at variance with those of other observers. While free to admit that the systematic examination of such cover-slip preparations in all cases of appendicitis might lead to the detection of the associated presence of two or more varieties of bacteria in a larger number of cases than my statistics indicate, I am nevertheless confident that the bacterium coli commune takes by far the greatest part in the bacterial origin of appendicitis.

I have repeatedly observed that if the cover-slip preparations be made from the contents of the appendix at a point somewhat removed from the seat of most manifest disease, a great variety of bacteria will often be disclosed. In the same case, however, preparations from the seat of more advanced disease, or from the peritoneal exudate or pus, will disclose but a bacillus morphologically identical with the bacterium coli commune. In a few cases cocci also were detected, but not in a greater proportion of cases than is indicated by the statistics as previously cited. I am inclined to consider the contaminating organisms in the first-mentioned instances as more or less innocuous, nonpathogenic, intestinal bacteria.

I have also taken opportunity to examine sections from a number of acutely inflamed appendices for the presence of bacteria in the various coats of the wall of the organ. The organisms that it was possible to identify were almost exclusively such as were morphologically similar to the bacterium coli commune. In exceptional cases some cocci were also seen. The micro-organisms were commonly within the lymph spaces, and were often some distance in advance of the cellular alterations. Of course, I am not unmindful of the fact that such evidence with reference to the identity of bacilli must be accepted with great reservation. It is extremely suggestive, however, that cocci were so regularly conspicuous by their absence, and that the bacterium coli commune was equally conspicuous by its presence,—not only in cover-slip preparations made from the intra-appendicular pus, extra-appendicular exudate, and pus, but also in the respective cultures and in the wall of the appendix.

Of the extreme virulence of the bacterium coli commune under certain conditions sufficient experimental and clinical evidence has been accumulated. When to this we add the fact that the conditions in the appendix are most favorable for the sudden and rapid increase in the virulence of a bacterium that may be innocuous, or almost so, in other portions of the intestinal tract, it seems to me that the predominating importance of this organism in the etiology of appendicitis can not be gainsaid. It can not be denied that the bacterium coli commune, under suitable conditions, proliferates most luxuriantly in culture media. Nor, on the other hand, can it be denied that the appendix is a most appropriate test-tube, and that the contents of the appendix are most suitable media, in which to cultivate a virulent growth of the bacterium coli commune. I believe, therefore, that as this organism outgrows other bacteria in artificial media, so also does it, under suitable conditions, assume a predominance in the appendix. This organ, like the intestine, under normal circumstances contains a variety of bacteria; but under conditions favorable for the development of appendicitis, particularly when the lumen of the appendix becomes occluded, the bacterium coli commune rapidly becomes the predominating and most virulent organism.

These statements naturally do not eliminate from consideration other bacteria as etiologic factors in inflammatory affections of the appendix. A number of other micro-organisms have been found sufficiently often by various observers, as well as by myself, and their virulence has been repeatedly tested, to indicate their importance in the production of appendicitis. Interest is attached to the detection by the author of the bacillus pyocyaneus in six cases of acute appendicitis and in two cases of chronic appendicitis. The pathogenetic importance of the streptococcus, when present, can not be overestimated, and the same is also true of the staphylococci. Of other bacteria encountered in appendicitis the following may be mentioned: Varieties of proteus, bacillus subtilis, bacillus capsulatus, coccus conglomeratus, bacillus fusiformis, bacilli resembling those of diphtheria, glanders, tetanus, actinomycosis, etc., and the pneumococcus, etc. The last-named organism was isolated by Barbacci from 60 per cent. of his cases, but the author has not encountered it.

Undoubtedly, in certain cases bacteria other than the bacterium coli commune do contribute to cause appendicitis; in some cases they are doubtless the sole etiologic factor. This is indicated by the fact that in certain of my own cases, as well as in those of other observers, this bacterium was absent, whereas other micro-organisms were present. It has been stated that undue prominence is assumed by the bacterium coli commune because of the property it possesses of invading tissues already the seat of morbid alterations inaugurated by other organisms. The latter, following invasion by the bacterium coli commune, are believed to assume a subsidiary rôle, and to become overshadowed by reason of the active proliferation of the invaders. Personally, I am inclined to accord predominance to that organism which, it is believed, so readily overcomes such well-known and virulent bacteria as the streptococci, etc., rather than believe that other organisms inaugurate the morbid condition in the appendix and then succumb to the activities of the bacterium coli commune. I believe that conditions are analogous in the appendix and in the test-tube; and that, further, as most of my examinations of acute cases were made very early in the attack, if bacteria other than the bacterium coli commune were so frequently concerned in the etiology of appendicitis, as is held by some, they would have been detected by the methods of investigation pursued.

As will appear later, the most important factor in the augmentation of the virulence of the bacterium coli commune in the appendix is defective drainage. When the drainage of the appendix becomes impeded or ceases entirely, the bacterium coli commune rapidly multiplies and increases in virulence, producing a toxin of very high potentiality. This, either alone or associated with the products of decomposition of the appendicular contents, suffices to inaugurate catarrhal alterations in the appendix. As a consequence of this, and also of the mechanical pressure exerted by the accumulating secretion, the mucous membrane becomes reduced in vitality, and invasion of the wall of the organ is a matter easy of accomplishment. The bacteria may successively invade each coat of the appendix until they reach the serous coat. Here they may give rise to a peritonitis, which may become suppurative, and may be either circumscribed or diffuse. It is thus that peri-appendicular suppuration arises in the absence of perforation of the appendix. As the bacteria penetrate deeper into the wall of the appendix, they commonly liquefy the tissues by peptonizing them, and, as a matter of fact, most cases of appendicitis with appendicular peritonitis present more or less ulceration of the appendix. In some cases the toxin elaborated is excessively virulent (and some of these are doubtless streptococcic), and there is wide-spread disease of the appendix, possibly gangrene, with virulent peritonitis, and still no perforation of the appendix. There thus can be no question that bacteria alone are amply capable of exciting appendicitis; that such appendicitis may be attended by ulceration in the absence of appendicular calculi; and that suppurative peritonitis may be associated with appendicitis without perforation of the appendix.

The differences in the severity of the clinical manifestations of cases of appendicitis are explicable upon the assumption of variations in the virulence of the toxins elaborated by the bacteria provocative of the inflammatory attack. In some cases it is likely that two or more varieties of bacteria acting in symbiosis produce a much more virulent composite toxin than would either alone. The leukocytes and nuclein are defenses provided by nature, but they are often ineffectual. The absorption of the toxins engenders the various general manifestations of the disease, of which the most important are albuminuria with casts; urobilinuria; indicanuria; a peculiar icteric tint of the skin; disturbances of cerebration, of cardiac action, etc. It is a peculiarity of the toxin of some cases which develop insidiously that it gives rise to symptoms which, for a time at least, much resemble those of typhoid fever.

*THE PATHOGENESIS.**

In considering the pathogenesis of appendicitis it must be borne in mind that inflammation of the vermiform appendix is in many respects so unique a disease; it differs so materially from inflammatory affections of other portions of the gastro-intestinal tract; it is often so sudden in its onset, so alarming in its aspects, and so disastrous in its consequences, that it behooves us to look for some cause or causes resident in or about the appendix itself to account for the much greater frequency of inflammation of this portion as compared with other portions of the gastro-intestinal tract, and for the preponderating rôle such inflammation plays in the etiology of peritonitis. As a matter of fact, there pertain to the appendix certain important anatomic and physiologic peculiarities that must of necessity exert considerable influence in the production of diseased conditions of that organ—that act as **predisposing causes.** The most important of these are: (1) The shape of the meso-appendix; (2) the excessive length as compared with the width of the appendix; (3) Gerlach's valve; (4) the histologic structure of the organ; (5) the blood supply; (6) the nerve supply; (7) the evidences of involution of the organ.

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*Consult: Kelly, A. O. J., "The Pathogenesis of Appendicitis," *Philadelphia Medical Journal*, IV, pp. 928, 983, and 1032, 1899.

The **meso-appendix** is of importance for several reasons. It not only acts as a predisposing factor in the causation of inflammation of the appendix, but it also has important bearings with reference to the possible results of such inflammation. The relations of the appendix to the peritoneum and vice versâ are various. As a rule, the appendix is completely enveloped by a fold of peritoneum, and lies free within the peritoneal cavity—it is an intraperitoneal organ. Exceptionally, however, its posterior surface is unprovided with a peritoneal covering. Under such circumstances the organ is in direct association with the retroperitoneal connective tissue, and this relation is of importance as influencing the course of possible peri-appendicular suppuration. Commonly, however, as already stated, it lies free in the peritoneal cavity and is almost invariably provided with a meso-appendix. The latter is usually triangular in shape, though it varies considerably in size, in thickness, and in the extent to which it is attached to the appendix. In the majority of instances the meso-appendix extends the entire length of the appendix. Exceptionally, however, the tip of the organ may be free; and more rarely, the meso-appendix may be attached to but the proximal two-thirds or one-third of the organ. It is, however, because of its size that the meso-appendix bears an important etiologic relationship to appendicitis. If it have a breadth commensurate with its length, or if it be very short or entirely absent, as far as the meso-appendix is concerned, the appendix will be quite straight. If, however, it be relatively narrow as compared with its length, the appendix will be correspondingly curved or distorted. Under such circumstances, depending upon the degree of the curve, flexure, or distortion, the free drainage of the appendix, so essential to its well-being, is compromised. As will be detailed later, when the free and thorough drainage of the organ is interfered with, one of the most important etiologic factors of appendicitis becomes operative.

The **excessive length of the appendix** as compared with its width, and more particularly with the caliber of its lumen, is another important etiologic factor in appendicitis, and this also because of the interference thereby engendered with thorough drainage. Appendices vary considerably in length, some being very short, others very long. The longest that the author has encountered was 14 cm. The average length is from 8 cm. to 9 cm. On the other hand, the diameter of appendices that appear not to have been diseased varies between 3 mm. and 5 mm., and there are often marked differences at different levels of the same organ. The relation, then, of the diameter of the lumen to the length of the appendix is about as 1 to 16 or 25—an evident disproportion, to which must be ascribed considerable pathogenetic significance. It appears that if the appendix once becomes the seat of disease, this disproportion is much accentuated. Thus, in over seventy-five per cent. of the appendices the seat of chronic inflammation that were examined the lumen had been reduced in diameter to 2 mm. or less throughout. In a number of the remaining twenty-five per cent. the lumen was but 2 mm. at certain levels, but exceeded this at others. Of those in which the diameter of the lumen was 2 mm. or less throughout, it was in many places 1 mm. or less. The pathogenetic significance of this disproportion between the caliber of the lumens and the length of appendices apparently healthy becomes much augmented if for any reason the lumen be diminished, as by chronic inflammation or otherwise.

The exact significance to be attached to **Gerlach's valve** is indeterminate, and this largely because that structure itself is very indeterminate. It is usually evident, when the cecum is viewed from within, as a small prominence of the mucous membrane surrounding, either completely or in part, the orifice of the appendix. Upon close inspection it is seen to be made up of a reduplication of the mucous membrane, and microscopic examination reveals, in addition, some lymphoid tissue. It is better developed in youth than in old age. It is said to be most marked in infants during the first year of life; in adults and the aged it often eludes detection by the unaided eye. Microscopic examination, however, usually reveals some indication of it. Krafft states that Nanninga has observed immediately below this valve a second smaller one. At all events the valve is admittedly a rather inconstant structure. Nevertheless, it can readily be surmised that when present it serves to retard the entrance into the appendix of intestinal contents, and to hinder, possibly to a less degree, the escape into the cecum of appendicular contents. It is this latter function that is the more important in this connection. If for any reason the region of the cecum about the appendicular orifice, or Gerlach's valve, become swollen, the escape of appendicular contents is more effectually prevented, defective drainage ensues, and appendicitis results.

The **histologic structure of the appendix** has important bearings upon the pathogenesis of inflammation of the organ. It is quite correct to state that in general the appendix conforms in histologic architecture to the structure of the large intestine, but it is, nevertheless, very unwise to lose sight of the many particulars in which it presents deviations from that type. That which is especially the most important is the presence in the mucous membrane of the appendix of a considerable amount of lymphoid tissue. These lymphoid cells at times infiltrate without definite arrangement the mucosa; at times they are collected into definite groups that are spoken of as lymphoid follicles. It is because of this richness in lymphoid tissue that the appendix has been aptly compared to the tonsil. It has been spoken of as the "abdominal tonsil," and comparison has been made between cases of "simple tonsillitis" and "simple appendicitis" (which Sahli even speaks of as "angina of the appendix"),—both of which are considered by some amenable to medicinal treatment,—and between suppuration of the tonsil and suppuration or sloughing of the appendix.

The amount of lymphoid tissue in the appendix seems to bear some relation to the age of the individual, and this may not be without significance in the etiology of inflammation of that organ. The author's investigations, which have been so largely with diseased appendices, hardly warrant him in formulating a positive opinion on this subject; they have, however, led him to believe, with Ribbert and Kelynack, that lymphoid elements are more abundant in the appendix during childhood than during later life. It is well known that affections of adenoid tissue are more likely to occur in the young than in the aged, and in some cases of appendicitis this fact is probably of etiologic importance—appendicitis being preeminently a disease of adolescence and early adult life. Ribbert states that the typical arrangement of the lymphoid elements into follicles is preserved until about the thirtieth year, when the follicles commence to undergo some atrophy and become more widely separated. Exceptionally, this physiologic atrophic process may be installed as early as the twentieth year. Ribbert and Kelynack, nevertheless, state that lymphoid tissue may be found in the appendices of the aged, and my own investigations certainly confirm this view. Ribbert mentions, also, that in the rabbit, more so than in man, the appendix is characterized histologically by the presence of such an amount of lymphoid tissue as to make it resemble a single large Peyer's patch. Hawkins, on the other hand, is reservedly inclined to believe that the amount of lymphoid tissue in the appendix does not bear any direct relationship to the age of the individual, but states that only the examination of a large number of normal appendices would warrant any definite statements on this subject. It is reasonable, also, to assume that those the subjects of the "lymphoid diathesis" are rather prone to appendicitis, as to affections of adenoid tissue in general, and in this connection the operations of heredity may not be without significance.

Another histologic peculiarity of the appendix of considerable significance is the relatively extensive epithelial surface that it presents,—extensive as compared with the size of the appendix. Under circumstances of even slight irritation or erosion it thus affords a large surface for the absorption of the noxious products of bacteria. This is further increased by the numerous crypts of Lieberkühn wherein the bacteria become lodged and continuously produce their toxins.

The **blood supply of the appendix** and the pathogenetic relationship that the blood vessels and the arterial supply bear to inflammation of that organ have been considerably studied. It is unnecessary here to go into a detailed description of the blood supply of the appendix, but some slight reference to the blood vessels themselves may be opportune. If I mistake not, it was Fowler and Van Cott who first directed particular attention to the important etiologic rôle of the circulatory apparatus of the appendix in inflammation of that organ. These authors believe that the appendix is peculiarly exposed to vascular and nervous, and hence to nutritional, disturbances, and base their opinion upon an examination of thirteen appendices sent by Fowler to Van Cott. The examination of these is said to have revealed in the vessels of the meso-appendix some form or other of obstruction to the blood current, either paravasculitis, perivasculitis, or endovasculitis; and these, it is believed, must have preceded the intense round-cell infiltration, the coagulation necrosis, the purulent foci, that they detected in the walls of the appendices. Van Cott also states that in several cases he found a distinct chronic interstitial neuritis with extensive atrophy of the nerve fibers resulting from hyperplasia of the endoneurium and perineurium. He argues from these that the real cause of the *locus minoris resistentiæ* admitting of bacterial invasion is not to be sought in a trauma of the mucosa, but in a trophic disturbance of the appendix, the result of chronic vascular lesion or of chronic nerve lesion, or both; and that the ulcerative processes in the appendix, while they may be increased by bacterial invasion, may nevertheless owe their origin to these trophic conditions.

These opinions have been subjected to critical investigation, and have commonly not been confirmed. In particular, Breuer, at the instigation of Nothnagel, carefully examined thirty appendices, some of which had been removed at necropsy and some at operation, among the latter there being instances of acute and chronic appendicitis. By means of carefully performed injection of the arteries, he first of all determined that the vascular supply of the appendix is not a terminal one, such as obtains in the brain, spleen, kidney, etc., but that a not inconsiderable collateral blood supply comes from the adjoining cecal vascular area. Furthermore, it was determined that these anastomosing arterial branches course partly beneath the mucosa, partly in the muscularis, and partly directly beneath the serosa. But as the pertinent result of his investigations, Breuer was unable to detect vascular alterations of the constancy and extent described by Van Cott. In cases of chronic inflammation of the appendix the larger arteries of the meso-appendix were regularly intact, even when surrounded by hyperplastic connective tissue. Not only this, but the smaller vessels—the arteries and veins—of various regions of the wall of the appendix revealed but rarely pathologic alterations. For instance, in areas in which the entire mucous membrane was converted into cicatricial connective tissue there were evident but slight thickening of the vessels, endothelial proliferation, etc.,—changes that, it is asserted, are detectable in every cicatricial tissue and in instances of normal involution of the appendix. In cases of acute suppurative appendicitis the alterations of the vessels were more common, but they were limited to the acutely inflamed region and its immediate vicinity. As the result of my own investigations, I believe there can be no question that Van Cott is correct in asserting that these vascular alterations are present in some presumably normal and in some diseased appendices, but I also believe that he erroneously interprets their significance and overestimates their importance.

In a considerable number of presumably normal appendices removed at necropsy and subjected to histologic investigation the thickness of the vessel wall of the appendix, as well as of the meso-appendix, impressed me forcibly. In many of these the deviations from the normal were almost exclusively confined to the muscular coat. In not a few instances, however, there was a distinct proliferation of the intima. The vessel walls of the remaining appendices appeared entirely normal. Pathologic alterations, particularly endothelial proliferation, were more common in the diseased appendices examined. In some of the appendices that had been the seat of recurring attacks of inflammation the thickening of the vessel walls was very apparent. In some of the acute cases the endothelial proliferation was equally conspicuous. In other appendices—those which for a shorter or longer time had been the seat of chronic inflammation, and which had more recently suffered an acute exacerbation—alterations of both the media and intima were evident. (Plate XII.) In many of the acute cases, however, the vessel walls presented no noteworthy deviations from the normal. Some interstitial connective-tissue overgrowth was also occasionally detected in and about the nerves of the meso-appendix, but by no means so regularly and constantly as indicated by Van Cott. As the result, therefore, of my own investigations considerable pathogenetic significance is ascribed to the condition of the arteries, but more to the blood supply. I believe that cases in which nerve lesions may with justice be held accountable for the development of appendicitis are quite exceptional. However, excluding instances of thrombosis and embolism of the chief appendicular vessels or their branches, and obstruction of the blood supply by means of torsions, angulations, or contracting bands of connective tissue compressing the vessels, I do not believe that ulceration of the wall of the appendix can with reason be ascribed to arterial alterations. I believe, though, that the precarious blood supply of the appendix may with justice be held at least partly accountable for the disastrous consequences to the appendix of causes therein provocative of inflammation, but which in other portions of the intestinal tract remain inoperative. I believe, also, that in case the blood supply of the appendix becomes very defective by reason of torsions, flexures, etc., conditions obtain in the appendix that render the common exciting causes of ulceration very prone to produce their deleterious effects. And, finally, I believe that many of the instances of proliferation of the endothelium of the vessels of diseased appendices are to be interpreted as the consequence, not the cause, of the inflammation.

The **indications of involution of the appendix** demand careful consideration, and the proper interpretation of suggestive alterations is frequently a matter for judicious discrimination. Particular investigation of this question has been made by Ribbert, Zuckerkandl, and Piersol. Ribbert examined 400 appendices obtained at necropsy and determined that 99 (25 per cent.) presented evidences of retrogressive atrophic alterations without indications of previous inflammation. These alterations were, therefore, interpreted as evidences of involution. Zuckerkandl investigated 232 appendices, and defected in 55 evidences of obliteration of the lumen—therefore in 23.7 per cent. Of 100 appendices of persons over twenty years of age examined by Ribbert, 32 presented these evidences of retrogression. The obliteration of the lumen was commonly but partial; it was complete in but 3.5 per cent. In one-half of the cases the distal quarter was closed; in one-half of the remaining cases the obliteration affected between one-fourth and three-fourths of the entire length of the appendix. In 14 per cent. of Zuckerkandl's cases the obliteration of the lumen extended throughout the length of the organ; in the remaining 9 per cent. the obliteration was but partial.

There can be no question that these evidences of retrogression are common. In the presumably normal appendices removed at necropsy that the author examined they were found in almost one-fourth of the cases. They were usually confined to the tip of the organ, and to a small portion of it. Exceptionally, they implicated about one-fourth, or a little more, of the entire length of the organ. In these cases the remainder of the organ presented no recognizable histologic deviations from the normal. These indications of involution were also evident in appendices manifestly the seat of inflammatory disease, and, as in the other cases, they were commonly limited to the distal end of the organ. In no case did they implicate as much as one-half of the appendix. In all these cases, however, the inflammatory character of the associated alterations was beyond question.

The exact nature of these involuntary changes is still more or less a matter of conjecture. Ribbert states that in appendices undergoing these alterations three zones can usually be recognized: (1) A central zone more or less rich in cells; (2) a zone which shows gradual transition from the first, and which is poor in cells and made up largely of connective tissue; and (3) the muscular coat. The first or inner zone corresponds to the former mucous membrane; the second or middle, to the former submucosa. The inner zone at times reveals a small, narrow slit, indicative of the former lumen. Careful examination of this, however, will often reveal a few strands of delicate connective tissue traversing it from side to side. These are readily torn and are likely to escape detection. Ribbert believes that the symmetry of the process, its progression from the distal to the proximal end of the appendix, and the absence of irregularities, of cicatricial tissue, and of other indications of previous inflammatory conditions justify the assumption that the process is involutionary in nature. It may be mentioned that this fact is indicated, in addition, by the absence of degenerative alterations in the mucous membrane—the change being rather one of gradual atrophy. The author believes, with Zuckerkandl, that the submucosa plays a most important rôle in these alterations, and that the changes in the other coats follow those of the submucosa. Piersol concurs in this opinion, stating that "changes within the submucosa inaugurate the process leading to the retrogression of the appendix and precede the alterations affecting the mucosa." Defective nutritive supply is doubtless the basis of the process. As regards the rôle that these involutionary changes play in the causation of appendicitis, it suffices for the present to state that they are to be considered as indicative of a *locus minoris resistentiæ*, which permits of the more ready operation in the appendix than in other portions of the intestinal tract of the exciting causes of appendicitis.

The foregoing, then, are the factors that predispose the appendix to attacks of inflammation. They acquire their pathogenetic significance because they interfere with the proper and thorough drainage of the organ; because they reduce the capability of the organ to resist the influences of various morbific agencies; because of the facility with which nutritional disturbances may be engendered; and because of the relatively large surface presented for the absoption of the toxic products of bacteria that find their exit from the appendicular lumen retarded or prevented. Bearing in mind these facts, when we institute a study of the pathogenesis of appendicitis, it is immediately patent that no one factor alone can be held accountable for the development of all cases of the affection. On the contrary, the previously mentioned anatomic and physiologic peculiarities of the appendix render the organ less resistant to the well-known morbific agencies provocative of inflammation in other portions of the body. In individual instances one or the other of these peculiarities predominates over, and thus assumes a pathogenetic significance disproportionate to, the others.

The **exciting causes of appendicitis** do not differ from those that induce inflammation in other portions of the body. As is well known, the most common causes of inflammation are mechanical and chemic irritation and bacteria. In a given case of inflammation it is often difficult to distinguish sharply between these etiologic factors, particularly between the action of chemic irritation and bacteria; in many instances there is certainly no distinction. In this respect, what is true elsewhere in the body, is true also as regards the appendix.

The bacteriology of appendicitis has already been discussed. Of the production of appendicitis by chemic irritants apart from bacteria we know very little. The development of appendicitis has been attributed by some, and probably with reason, to the presence of lead in the appendix. It has been conjectured that the lead either of itself acts as the necessary irritant or that it in some way so influences the appendix as to favor infection. Reports have also been made of cases of appendicitis occurring in association with the so-called gouty diathesis, or during the course, or following an attack, of rheumatism, influenza, etc. It is extremely likely that the origin of these cases is closely connected with the operations of bacteria. Our information in this realm, however, is very meager. That mechanical irritants, such as traumata, act as exciting causes of appendicitis is evident from the development of appendicitis following injuries, such as blows in the region of the appendix, sudden straining efforts, etc. These traumata act as do traumata generally, reduce the vitality of the appendix, and permit of the more ready operation of the exciting cause of appendicitis—bacteria. Byron Robinson considers that the chief exciting cause of appendicitis is the action of the right psoas muscle, and Edebohls believes that a movable right kidney is of prime importance. He states that chronic appendicitis is present in from 80 per cent. to 90 per cent. of women with symptom-producing movable right kidney, and that chronic appendicitis is one of the chief, if not the chief, symptom of movable kidney.

It is well remembered that early in the development of our knowledge concerning appendicitis the origin of the disease was commonly attributed to the presence in the appendix of various foreign bodies, such as cherry-stones, grape-seeds, seeds of various other fruits, pins, needles, hair, bits of bone, gall-stones, and the like. Of recent years, as a result of more careful investigation, it has become evident that many of the formations previously considered seeds of various fruits were in reality but fecal concretions or appendicular calculi, the misconception as to their real nature being due to the resemblance that they bore in size and shape to the different objects for which they were mistaken. Undoubtedly, foreign bodies do gain access to the appendix, and in the event of that organ subsequently becoming the seat of inflammation, it is but natural to ascribe an etiologic rôle to such foreign body. The frequency of the occurrence of foreign bodies in the appendix is indicated by the recent communication of Mitchell, who, among 1400 cases collected from various sources, found foreign bodies in about 7 per cent. The statistics of various observers differ somewhat. Thus, Fitz, in 152 cases of perforative appendicitis, found fecal concretions in 47 per cent. and foreign bodies in 12 per cent. Renvers reports some collective statistics, comprising 459 cases, in which fecal concretions were found in 179 (39 per cent.) and foreign bodies in 16 (3.5 per cent.).

Matterstock, in 169 cases of appendicitis, found fecal concretions in 53 per cent. and foreign bodies in 12 per cent. Ferguson found foreign bodies, including enteroliths, orange-pips, cherry-stones, etc., in 15 (7.5 per cent.) of 200 cases, and Murphy, in 141 operative cases, found foreign bodies in 5 (3.5 per cent.), and fecal stones in 43 (30 per cent.). Hawkins did not find any foreign bodies in 67 fatal cases. Mitchell states that in 250 cases of appendicitis in Johns Hopkins Hospital there occurred but one foreign body—a segment of a tape-worm. Mitchell mentions the following as among the foreign bodies that have been found in the appendix: Shot (122 shot in one case), pins, worms, gall-stones, a tooth, pieces of bone, grape-seed, date-seed, cherry-stone, apple pips, oat husk, corn husk, bristle of a tooth-brush, wisp of a broom, fin of a fish, etc. Curiously, a pin is at once one of the most frequent and most dangerous foreign bodies found in the appendix.

Mitchell, who has collected from the literature a total of 36 cases in which pins have been encountered in the appendix, states:

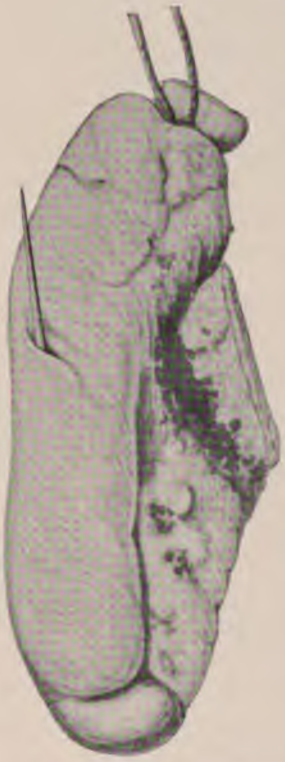
> "One would naturally suppose that such a foreign body in the appendix would lead to rapid perforation; but, while this is generally the case, it is not always so. All types of appendicitis may result. Some give rise to only mild symptoms, and may lead to chronic appendicitis (7 cases) with recurrent attacks, or with long-continued pain, or only a feeling of uneasiness in the right iliac region, which may last for months or years, and perhaps finally end in an abscess (Cases 14 and 15). Most often, however, there is rapid perforation and abscess formation, following the first appearance of the symptoms. The pin may enter the appendix by its head or point. It is generally straight, lying in the lumen of the appendix with its long axis parallel to that of the appendix, and perforating with its point. In one or two instances, however, it lay directly across the lumen and perforated with its head one wall, and with its point, the opposite. Dr. McBurney removed an appendix which contained two pins lying side by side and perforating the opposite walls of the appendix in this manner. On two occasions pins have been found in appendices contained in hernial sacs. The pin may be free from deposit, rusty, or corroded. Usually, however, it is the nucleus of a fecal concretion which covers the head and most of the shaft, leaving the point free. . . . While many curious and unexpected things are occasionally found, the appendix would nevertheless seem to act especially as a trap for pointed bodies and for small heavy objects, like shot or bullets. . . . Those foreign bodies of light weight, like grape-

ACUTE APPENDICITIS WITH A PIN IN THE APPENDIX.—Mrs. A. G., aged thirty-six years, was admitted to the German Hospital during May, 1897, and the following history was elicited: Ten days prior to admission she was suddenly seized with sharp pains in the right side and vomiting. The abdominal wall became rigid and markedly tender upon pressure in the region of the appendix. Constipation was present. The vomiting continued for two days, but the pain, tenderness, and rigidity, though they decreased in intensity, continued for one week.

On admission her temperature was 101° F.; her pulse-rate, 112. There was neither nausea nor vomiting. Her abdomen was slightly distended, and in the right iliac fossa, close to the iliac spine, there was a mass that was *not* painful on pressure. Moderate tenderness could, however, be elicited on deep palpation. Appendicitis was diagnosed, but, on account of the absence of pain and tenderness in the mass over the appendix, which seemed an anomalous condition, operation was deferred for one day. The patient's temperature, however, steadily rose to 103° F., and immediate surgical interference was considered necessary.

At operation the abdominal muscles were found thickened, and the parietal peritoneum was adherent to a mass which consisted of the omentum and the appendix bound together by some partly organized exudate. The appendix was freed, ligated, and removed, and found to contain a black pin.

The case is interesting because, despite the presence of a mass, pain and tenderness were not marked. It also indicates that, in the absence of great local tenderness, a diagnosis of pus in or about the appendix is not warrantable.



Showing Appendix containing Pin. (Twice natural size.)

> seeds and cherry-stones, so popularly assigned as a cause of appendicitis, . . . are in reality exceptional, and their frequency is much overestimated on account of the close resemblance of fecal concretions and the lack of careful examination of the bodies described."

My own investigations certainly indicate the infrequency of foreign bodies as a cause of appendicitis. With the exception of the pin in the appendix illustrated in Plate XXII, I do not recollect having encountered a single foreign body in any of the appendices examined. It is interesting to recall that various enterozoa have been found in the appendix. Thus, the oxyuris vermicularis, the trichocephalus dispar, and the ascaris lumbricoides have been encountered. In addition, Scholler has reported a case of echinococcus of the appendix in association with echinococcus of the liver, and Birch-Hirshfeld an instance of echinococcus of the appendix alone.

While, in the light of recent experimental and other scientific research, the views formerly maintained with regard to the rôle of various foreign bodies in the production of appendicitis has largely been abandoned, the relation of what we now know to be appendicular calculi to the development of appendicitis still demands careful consideration. That calculi may be borne in the intestinal tract and in the appendix without inducing any important pathologic process is well established as a result of the investigations of a considerable number of observers, and is being constantly confirmed by all who have occasion to see much necropsy work. On the other hand, that calculi are associated with a considerable number of cases of appendicitis is equally well established. The statistics of various observers with regard to the frequency of appendicular calculi in appendicitis have already been cited. Of 460 of the cases examined by myself they were found in 74 (16 per cent.)—35 of a total of 208 acute cases, and 39 of a total of 252 chronic cases. The 35 instances in which they were found in cases of acute appendicitis were distributed among the different varieties of this affection as follows:

Of 7 cases of acute catarrhal appendicitis, . .	None.
" 32 " " " interstitial " . .	2 (6.2 per cent.).
" 56 " " " ulcerative " without perforation, ...	9 (16.0 "
" 64 cases of acute ulcerative appendicitis with perforation, ...	19 (29.8 "
" 49 cases of acute gangrenous appendicitis, .	5 (10.2 "
Of 208 cases of acute appendicitis, calculi in, . .	35 (16.6 per cent.).

From these statistics it is evident that calculi are present in a considerable number of cases of acute appendicitis, and it is further plain that the more severe the inflammatory lesions, the greater the proportion of cases in which they are found. Thus, they are more common in cases of ulcerative appendicitis, especially with perforation, and in gangrenous appendicitis, than in any of the other acute varieties. There can, however, be no question that they are even more often associated with some varieties of acute appendicitis than the foregoing figures indicate. It not infrequently happens in cases of ulcerative appendicitis with perforation, and in gangrenous appendicitis, that at the time of operation or necropsy the calculus has already escaped from the lumen of the appendix and is not detected during the operative manipulations, or, being detected, is not preserved.

The relation of these calculi to appendicitis, however, is not the simple one of cause and effect, as was originally assumed. A consideration of the anatomy of the cecum and appendix is sufficient to indicate the impossibility of formed calculi, even of small size, gaining access to the appendix—at all events, after the first year of life. (During the last-named period the appendicular orifice is often quite patulous.) This view has been confirmed, if such confirmation were necessary, by some experimental investigations. Calculi, therefore, are formed within the appendix.

The condition of the cavities of normal appendices removed at necropsy varies in different instances. It has been found entirely empty; but in most cases it is partly or completely filled with fluid or semi-fluid fecal matter. It is natural to infer that such fecal matter frequently gains access to, and is as frequently expelled from, the lumen of the appendix by the muscular contractions of the organ, which are aided by the shape, position, length, caliber of the lumen of the organ, etc. If such fecal matter remain long in the appendix, it becomes inspissated, in consequence of the rapid absorption, by the numerous lymphatics, of its watery constituents. The longer it remains, the more inspissated it becomes. It is probably the efforts of the appendix to expel such inspissated fecal matter and calculi that give rise to attacks of appendicular colic. the occurrence of which can not well be doubted. Nor can it be doubted that such colicky pain occurs in the absence of calculi and fecal matter from the appendix. The irregular peristalsis of an inflamed and ulcerated appendix is of itself sufficient to give rise to acute pain, which increases in wave-like exacerbations—the manifestations being similar to the tenesmus of a posterior urethritis or a proctitis. If the egress of fecal matter from the appendix be hindered by inappropriate position or fixation of the organ, internal constrictions, external bands of cicatricial connective tissue, swelling of the mucous membrane or of Gerlach's valve, flexures, angulations, weakness of the muscular coats, impassiveness of the organ, or other causes, the contents become correspondingly more inspissated. From what was originally a mass of fecal matter of greater or less size, there thus results a small, hardened, fecal particle. Around this as a nucleus there are deposited, in successive concentric layers, inspissated mucous, desquamated epithelial cells, pus-corpuscles, debris, etc. These, collectively, result in the formation of a so-called fecal concretion. Inasmuch, however, as only the central nucleus of this concretion consists of fecal matter, the remainder of it being made up of the products of inflammation, etc., the preferable designation is appendicular calculus.

Chemic investigation of these calculi shows that they are composed of phosphate, carbonate, and sulphate of calcium; phosphate of magnesium; at times cholesterin, fat, debris, etc. Interesting investigations have recently been made by Ribbert, who, in addition to confirming the older view, according to which the center of the calculus alone is made up of fecal matter, showed, by means of Weigert's fibrin stain, that the mucus of the outer layers of the calculus is in continuous association with that filling up the mucous glands lining the appendix. It is quite likely that fecal matter of itself, if retained in the appendix for some time, is capable of setting up some catarrhal inflammation, and this, probably, as a consequence not only of attrition of the lining membrane, but also of increase in the virulence of the retained bacteria. This is indicated by the many instances of catarrh of the appendix found at necropsy in the absence of calculi. This catarrh of the appendix is one of the most fertile sources of appendicular calculi. Not only do the swelling and edema thus produced retard the exit of fecal matter from the appendix and favor its inspissation by affording opportunity for the absorption of its watery constitutents, but the products of the catarrhal inflammation itself furnish the necessary ingredients—the salts—to be deposited in layers about the nucleus of fecal matter.

Calculi in the appendix vary in number, size, shape, and color. They may be single or multiple. Usually, there is but one; there are often two; there are rarely more than four. According to Volz, they vary in size from that of a lentil to that of a hazelnut. The largest calculi that I have encountered were from a case of gangrenous appendicitis of five days' duration, the patient being reported never to have had any previous attacks. The appendix removed at operation contained three concretions. The largest was 2 cm. in length and 1.2 cm. in diameter; the second, 2 cm. in length and 1 cm. in diameter; and the smallest, 0.8 cm. in length and 0.4 cm. in diameter. The calculi are usually elongated; though some are relatively much thicker than others. They are commonly rounded at the extremities. Sometimes, however, they are distinctly conoid or pointed, as were the two largest of those the dimensions of which have just been cited. Externally, they may be smooth or rough. In color they are grayish-white, yellowish, or brownish. On section, they present a distinctly lamellated concentric structure, and are harder toward the center than toward the periphery.

Sonnenburg, writing of the formation of such calculi, or, rather, of the deposition of successive layers about the central nucleus, asserts his belief that there must have existed a dilatation of the appendix at the site where such calculi have formed. He believes that the deposition of successive layers is impossible in case the wall of the appendix surrounds the calculus firmly as an unyielding band, and that, therefore, a certain space is essential in order that mucous and other ingredients may gain access to the fecal particle. The roundish form of the calculi is also thought to indicate that they have been subject to more or less movement. Were there not a certain free space, calculi of excessive size would certainly lead to rupture before they do. Be these suppositions as they may, calculi certainly form part of a vicious circle in appendicitis. Originally, they are hardly the cause of appendicitis; rather are they the result of inflammation of the appendix. But having resulted from an attack of appendicitis, they are an important factor in continuing the inflammation, in furnishing the necessary irritant to incite renewed attacks of acute exacerbation, and in contributing to some of the most disastrous consequences of appendicitis—perforation and consequent purulent peritonitis. Granting that the attainment of a certain size presupposes more or less of a free lumen, when that size has been reached, the constant pressure and attrition of the calculus naturally results in further inflammation, erosion, ulceration, and perforation. As already intimated, catarrhal inflammation, with hypersecretion of mucus, desquamation of epithelial cells, and purulent exudate, afford ample opportunity for the increase in size of the calculi; the inflammation renders the wall of the appendix less resistant both to the operations of bacteria and to the mechanical effects of the calculi; and the implication of the muscular coats lessens or prevents peristalsis and diminishes the likelihood of the extrusion of the calculus.

Considering, now, the relative rôles played by bacteria and appendicular calculi in the causation of appendicitis, it seems to the author that it may be unhesitatingly asserted that appendicitis is, without exception, an infectious process; that the inflammations of the appendix are the results of the activities of bacteria; and that the rôle of calculi is quite subsidiary to that of bacteria. Such being the case, the queries naturally suggest themselves: Why is it that bacteria normally present in the intestinal tract are provocative of such serious pathologic lesions in the appendix? and why is it that calculi innocuous, or almost so, in the intestine are associated with inflammatory affections of the appendix? The reasons for these are to be found in the anatomic and physiologic peculiarities of the appendix, of which mention has already been made. These, on the one hand, decrease the capability of the organ to resist the influences of various morbific agencies, and, on the other, afford opportunities for the rapid increase in virulence of bacteria contained within the appendix. Because of the previously detailed anatomic and physiologic peculiarities, morbific agencies that are readily overcome by the normal physiologic activities of the intestinal tract are capable, when present in the appendix, of inducing the most deleterious consequences. And, in addition, when these morbific agencies—principally bacteria—become heightened in virulence, they effect their disastrous results much more readily. It must also be borne in mind that disease is due not alone to the virulence of the determining cause,—be it bacteria, trauma, or other cause,—but is dependent to a considerable degree upon the predisposition of the individual, upon the vitality, the power of resistance, not only of the part affected, but also of the general economy.

To recapitulate: The factors that operate to render the appendix less resistant than other portions of the intestinal tract to the onslaughts of bacteria and other determining causes of appendicitis are several. Of prime importance is the precarious blood supply and the consequent anemia of many of the appendices. The blood supply is defective not so much because of the manifest alterations frequently demonstrable in the walls of the blood vessels of presumably normal appendices, but also because of the liability of the occurrence of partial or complete obstruction of the blood channels as a result of angulations, torsions, external constricting bands of adhesions, etc., and of infective endovasculitis secondary to primary inflammation of the appendix. Disturbances of circulation, and hence of nutrition, are also produced by active, and sometimes ineffectual, peristalsis of the appendix, induced by an effort to rid itself of foreign bodies, calculi, or even inspissated fecal matter. The action of such circulatory and nutritional disturbances is further evident in the intense congestion often noted distal to an appendicular calculus about which the wall of the appendix may be firmly contracted, and by the fact that, under these circumstances, when perforation occurs, the part affected is not directly over the site of the calculus, but rather distal to this—the region of the previous intense congestion. Of importance in a limited number of cases is also, doubtless, alterations in the nerves supplying the appendix; but, as already stated, it is believed that these are not of such great importance as has been suggested by Fowler and Van Cott. Finally, in this connection, not without significance are the evidences of retrogression of the appendix, indicating, as they do, defective powers of resistance. The factors that in the appendix give rise to increase in the virulence of the bacteria normally present in the intestine are primarily such as interfere with thorough drainage of the organ. Defective drainage may supervene when, for any reason, the appendix is so situated that it can not be readily emptied; when its lumen is constricted, either externally by bands of cicatricial connective tissue (peritoneal adhesions), tumor formations, etc., or by cicatrices of its wall, or by obstructions within its lumen (as, for instance, by calculi or foreign bodies); or when the muscular coat of the organ is no longer capable of active peristalsis, as is likely to be the case when the appendix is itself diseased or bound down by adhesions. Congestive disturbances of the appendix or of the cecum may cause such swelling of the mucous membrane as to lead to approximation of the opposed surfaces in the appendix, or to occlusion of the outlet of the organ, and thus effectually prevent drainage. Of considerable significance with reference to this question of drainage are certain of the anatomic and physiologic peculiarities of the organ previously described. Of these, may be mentioned the size and shape of the meso-appendix, the excessive length as compared with the caliber of the lumen of the appendix, and Gerlach's valve. As further conducive to imperfect drainage are the already mentioned torsions, angulations, peritoneal adhesions, cicatrices of the wall of the appendix, etc., which interfere not alone with the blood supply, but also with thorough drainage. Appendicular calculi are capable of at least a twofold action, and that within a vicious circle. Originally resulting from, rather than causing an attack of, appendicitis, they may not only occlude the lumen of the organ and prevent drainage, but they may also induce passive congestion in that portion of the appendix distal to their situation, and by attrition—the result of constant or intermittent peristalsis—cause erosions of the mucous membrane, and thus reduce the power of the organ to resist the attacks of bacteria and their toxins. When small, these calculi are often doubtless innocuous; but when they have attained a considerable size, and are no longer capable of being extruded, they may engender the most disastrous consequences. The erosion and necrosis of the mucous membrane resulting from constant attrition progress, affecting all the coats, until perforation may be produced. As the erosion or ulceration increases there is afforded a favorable focus for the ready invasion of bacteria and the free absorption of their toxins. Thus, while calculi are of subsidiary importance in exciting the original attack of appendicitis, it is believed that in many cases they are of very great importance in determining perforation of the appendix and the situation of the perforation. These are evident from the preponderating number of cases in which calculi are found in ulcerative appendicitis with perforation, and in the direct association of the calculus with the site of the perforation. In addition, appendicular calculi are of considerable significance in the production of chronic recurring appendicitis, in provoking the acute exacerbations in a chronically inflamed appendix.

The preponderating importance of defective drainage in the pathogenesis of appendicitis is sufficiently evident from an examination of a large number of diseased appendices, but it finds additional confirmation from the clinical and pathologic observation of analogous intestinal conditions and from some experimental investigation. Increase in the virulence of bacteria, particularly of the common colon bacillus, has been found not only in the appendix when its lumen has been obstructed, but also, as already mentioned, in cases of intestinal obstruction and strangulation, in various congestive and diarrheic conditions, and even in some cases of marked and long-continued constipation. The experimental investigations of Roux, Roger and Josué, Dieulafoy, Frazier, and others are especially noteworthy as indicating the increase in the virulence of the common colon bacillus in the appendix when its lumen is occluded. A hollow glandular organ remains intact only as long as the production and evacuation of its secretion goes on normally. As soon as there occurs a disturbance, either over-production or diminished evacuation, disease results. If the excretory duct of the gall-bladder be occluded, there ensues, under varying circumstances, either a hydrops, an empyema, or a cholecystitis or a cholangitis. The same is also true of the mammary gland, of the sebaceous glands of the skin, and of the appendix. When the lumen of the latter becomes obstructed, there occur retention, stagnation, and decomposition of its contents. This stagnation contributes also to the vicious circle, in that it not only exerts a deleterious influence on the wall of the appendix by reason of the mechanical pressure to which it gives rise, but it also serves as a most suitable culture medium for the growth of bacteria. When to the products of decomposition there are added the toxins produced by the retained bacteria increasing in virulence, the cause of appendicitis is self-evident.

As additional factors of importance are the relatively large extent of mucous membrane presented by the appendix and the large amount of lymphoid tissue, not only in the neighborhood of Gerlach's valve, but also scattered throughout the wall of the appendix. The latter is of especial significance in view of the proneness of adenoid tissue throughout the body to inflammation whenever subject to even slight irritation by bacteria and their toxins. The mucous membrane, particularly if it be eroded or ulcerated, presents a very large surface for the ready invasion of bacteria and for the absorption of their toxins. This latter is of especial importance in the production of gangrene of the appendix—the result often of infective thrombosis or embolism following erosion or ulceration of the wall of the appendix.

It must also be remembered that the appendix is prone to participate in severe intestinal lesions, particularly those of typhoid fever and dysentery; and while the latter may subside without the production of appendicitis, there frequently persist sequels, in the form of cicatrices, etc., that are not without significance in the causation subsequently of inflammation of the appendix. Further, Klecki and other investigators have shown that the bacterium coli commune differs in virulence in various portions of the intestinal tract. It is most virulent in the ileum, less so in the jejunum, and least virulent in the duodenum and colon. It is conceivable that the attacks of indigestion accompanied by diarrhea that in many instances precede the outbreak of appendicitis may result in the conveyance to the appendix of virulent bacteria, and that these overcome the resistance of the appendix more readily than do the less virulent bacteria normally present in the appendiculocecal region. On the other hand, increase in the virulence of the bacterium coli commune has been found in the cases of marked constipation which, as is well known, sometimes precede the development of appendicitis.

From the foregoing, therefore, it is evident that no one factor alone can be held answerable for the production of all cases of appendicitis. Although the affection is without exception the consequence of micro-organismal infection, it is of rather complex pathogenesis, and no one morbific agent is provocative of all attacks. It is because of the anatomic and physiologic peculiarities of the appendix that factors innocuous in the intestine, or morbific agents capable of being successfully combated by the physiologic activities of the intestine, become, in the appendix, of heightened virulence, and, meeting lessened resistance, engender the most disastrous consequences. Finally, it is interesting to mention that Goluboff regards appendicitis as an infectious disease *sui generis*, as is follicular tonsillitis, dysentery, etc., and that he expresses the opinion that, in addition to the occurrence of sporadic cases, the affection may develop epidemically—that it is then an epidemic infectious disease. But this view can hardly be maintained with reason.

SYMPTOMATOLOGY.

In considering the symptomatology of acute appendicitis it must be borne in mind that it is not always possible to determine the pathologic alterations in the appendix from the clinical manifestations of the disease. It is futile to ascribe to any symptom or symptom-complex pathognomonic significance with regard either to the progress or to the stage of the affection. It is true that there is a symptom-complex which, when present, warrants us in assuming the existence of catarrhal or mild interstitial appendicitis; there is another symptom-complex that suggests appendicitis with circumscribed peri-appendicular suppuration; and there is still another symptom-complex indicative of appendicitis with diffuse peritonitis. Such, however, are the manifold differences in the clinical manifestations of similar anatomic lesions of the appendix that the establishment of sympton-complexes that shall indicate definite pathologic lesions of the appendix is impossible. There can be no question that reliance upon such symptom-complexes as have been formulated frequently leads to egregious diagnostic blunders. While it is true that, in general, the clinical manifestations become more marked with increase in the severity of the appendicular and peritoneal lesions,—that is, when perforation, pus formation, or gangrene supervene,—it is also a fact that remission of all symptoms except local tenderness may occur, and yet the disease may be progressing to a fatal termination. It is likewise a fact that the symptoms suggestive of perforation of the appendix and peri-appendicular suppuration in one patient may arise in another patient in consequence of the development of peri-appendicular suppuration without perforation of the organ. It thus seems rational not to attempt to separate clinically cases of appendicitis into groups,—such as mild or nonperforative, perforative, gangrenous, etc.,—but to describe acute appendicitis as a clinical entity whose manifestations seem more dependent upon the virulence of the infection and the resistance of the individual than upon the character of the lesions of the appendix and the surrounding peritoneum. Similar reasoning obtains with regard to chronic appendicitis, although in the latter the questions requiring solution are less complicated. In the vast majority of cases of chronic appendicitis the entire organ is affected, and such can be assumed with justice in the presence of the appropriate clinical symptoms. The existence of merely catarrhal alterations may seem warranted in some cases, but examination of the excised appendix will usually reveal pathologic lesions of all the coats. It need scarcely be mentioned that obliterative appendicitis can not be recognized clinically.

The symptomatology of two forms of appendicitis—the acute and the chronic—will be described. The acute form embraces those varieties of inflammation of the appendix usually described clinically as simple catarrhal, ulcerative, perforative, fulminative, or grangenous, and which, upon examination of the excised appendix, reveal acute catarrhal or interstitial inflammatory alterations, ulceration with or without perforation, or partial or complete gangrene. These terms represent in great part only differences in the degree and extent of the local inflammatory phenomena—differences between which it is impossible in all instances clinically to draw a distinction. The chronic form of appendicitis includes those varieties described clinically as subacute, chronic, relapsing, and recurrent, and which, upon examination of the extirpated appendix, reveal chronic catarrhal and interstitial inflammatory alterations, with or without ulceration, progressing in rare instances to obliteration of the lumen of the organ —obliterative appendicitis.

ACUTE APPENDICITIS.

There are three symptoms of acute appendicitis so constant and, when associated, so characteristic of the affection that I have designated them the "three cardinal symptoms." These are pain, tenderness, and rigidity of the right lower quadrant of the abdominal wall.

Pain is the initial symptom, and usually follows the ingestion of food which either is indigestible or has been improperly masticated and hastily swallowed. At the onset of the affection the pain is paroxysmal or colicky in character, in which respect it simulates an attack of acute indigestion or, in aggravated cases, of biliary or nephritic colic. This pain usually develops suddenly, continues a variable length of time, recurs at irregular intervals, and is distinctly cramp-like in character. It leads to flexion of the right thigh and to a general favoring of the right side of the body. Such may be its intensity that sudden evacuation of the bowels, vomiting, and great prostration may develop.

The paroxysmal character of the initial pain in the majority of cases can not be too strenuously insisted upon. Indeed, such is the character and severity of the pain in many instances that there have occurred numerous cases in which it has been attributed by reputable physicians, as has been intimated already, to biliary or nephritic colic. Because of its character the term appendicular colic has been applied to it. This designation, however, has been objected to, because, it is asserted, the pain is inflammatory and not functional in nature. This is partly, but not entirely, true. The pain is indeed inflammatory, and this, I believe, aggravates it, but it is also, in part at least, functional. It is not necessary to assume that it is an effort on the part of the appendix to rid itself of appendicular calculi or foreign bodies that give rise to the pain. Indeed, the improbability of such in the majority of cases is evident from the fact that such calculi are found in some appendices that are quite normal, and that they are entirely absent from some appendices despite the occurrence of the most severe paroxysmal pain. It is generally assumed that in health the appendix empties itself of accumulated secretion and fecal matter by its normal peristalsis. In view of the fact that we are now aware that defective drainage is one of the most important factors in the production of appendicitis, the consequences of the accumulation and stagnation of the secretion of the appendix are self-evident; and it is but fair to assume that the effort of the appendix to rid itself of such accumulated secretion (to which is opposed some barrier) is sufficient to engender colicky pain. In this respect the pain is quite as functional as is that which attends the efforts of the gall-bladder or kidney to free themselves of calculi. In the event of the appendix being inflamed, such pain is naturally much aggravated. On the other hand, peristalsis of an inflamed appendix is of itself sufficient to give rise to paroxysmal pain; and the more extensive the ulceration and consequent exposure of nerve filaments, the more severe is likely to be the pain. And this may be further aggravated by the presence of an appendicular calculus. The irritation in these cases is reflected along the numerous branches of the superior mesenteric plexus of the sympathetic nervous system, some of which supply the appendix with both afferent and efferent nerve fibers.

The pain continues of a colicky character for a greater or less period of time. The paroxysms, however, gradually lessen in number and severity, and the pain persists, being continuous and of moderate intensity. Acute exacerbations may nevertheless occur from time to time. These either arise spontaneously or are provoked by various causes. Thus, palpation of the affected area, motion of the right thigh which causes contraction and relaxation of the psoas muscle, bending of the body to the left, deep inspirations, coughing, sneezing, etc., may either excite or intensify the pain. Later on in the course of the attack the pain may moderate considerably, and this, often interpreted as a good omen, is frequently, in reality, but an indication of perforation, gangrene of the appendix, or impending dissolution. In some exceptional cases the pain is non-paroxysmal, constant, and dull from the very onset of the attack. This is especially likely to be the case in recurring attacks, when the pain is often described as of a peculiar boring character.

The location of the initial pain in the majority of instances is the umbilical or peri-umbilical region; next in order of frequency, the epigastrium; and least commonly, the right iliac fossa. The typical pain of an attack of acute appendicitis is that which develops suddenly in one previously healthy, is cramp-like in character, referred to the umbilical or epigastric regions, or is diffuse, and which later becomes localized to the right iliac fossa. In recurring cases the initial pain of the later attacks is often referred immediately to the right iliac fossa. The pain of appendicitis may, however, be referred to any region of the abdomen. It is a lack of knowledge of this fact that has led to many errors of diagnosis in acute abdominal affections.

The location of what may be termed the secondary pain in an attack of acute appendicitis varies somewhat in different cases. It depends to a great extent upon the position and direction of the appendix. After the development of a circumscribed peritonitis it is usually referred to the right iliac fossa, because the appendix commonly occupies this region of the body. Not uncommonly, however, it is referred to the left side of the abdomen. If the appendix be long, with its tip overhanging the brim of the pelvis, the pain will be referred to the left side of the abdomen, along the course of the spermatic cord toward the testicle, or to the region of the ovary, or to the left side of the pelvis. If the appendix be post-cecal and point north, the pain may be referred to the loin or back; at times, if it point north, lying either in front of or behind the cecum, the pain may be referred to the region of the kidney or the liver. When the appendix rests upon the psoas muscle and is in relation with the anterior crural nerve, the pain may be referred to the thigh along the course of this nerve, and even to the knee. The pain in other cases may be referred to the area of distribution of the right genito-crural nerve—the testicle or vulva and the upper anterior and inner part of the thigh. With the pain referred to the right testicle, there may occur retraction of this organ, in which respect there develops a marked resemblance to an attack of nephritic colic. In still other cases the pain may be referred along the inguinal branch of the ileo-inguinal nerve, to the inguinal canal, etc. At times the pain is more diffuse, but under such circumstances it is usually most marked in the right iliac fossa. If, however, the tip of the organ occupy the left iliac fossa, or if the entire appendix be situated in this region, as occurs in transposition of the viscera, the greatest amount of pain will be referred to this region.

Tenderness upon pressure is one of the most constant and valuable signs of appendicitis. It is always present. The area of tenderness in the beginning of an acute attack is small, and is limited to the site and position of the appendix. This is usually at McBurney's point, a point located midway between the umbilicus and the anterior superior spine of the right ilium, and a point that marks the position of the base of the appendix. It is natural to expect that the tenderness should be over the seat of the most marked disease of the appendix. As a consequence, the most tender point varies more or less with the position of the appendix. As already stated, the greatest tenderness is usually at McBurney's point, but if the appendix be post-cecal and the rigidity of the abdominal walls marked, tenderness is sometimes difficult to elicit, and its detection may require deep palpation. When the appendix is long, the point of greatest tenderness may be upon the left side, in the lumbar region (requiring deep palpation for its discovery), or in the pelvis. When the pain is referred to the left side, as a consequence of the appendix projecting into the pelvis, pressure over the painful area increases the pain upon the left side, and excites pain also upon the right side. The tenderness, when situated in the pelvis, may not be detected except by rectal or vaginal examination, the value of which in many instances can not be overestimated. Naturally, in women the possibility of the tenderness being the consequence of inflammation of the right tube and ovary must be borne in mind, and a differential diagnosis should be attempted.

While, as intimated, the point of greatest tenderness is usually over the inflamed appendix, there are some exceptions to this rule. Thus, in a young adult I recently found the point of greatest tenderness to the left of the left rectus muscle, a little above the level of the anterior superior spine of the ilium. By rectal examination a small and very sensitive mass was detected in the recto-vesical fossa. Operation demonstrated that the appendix occupied the latter situation. On the other hand, I recall cases in which the point of greatest tenderness was immediately above the middle of Poupart's ligament. This, as demonstrated by operation, corresponded in position with an acute curve in the appendix. In these cases the appendix originated from the postero-external aspect of the base of the cecum. Thence it descended in front of the cecum as far as its apex, where it abruptly curved upward.

After the remission which often follows the sudden severe primary pain there sometimes remain only tenderness and rigidity of the abdominal muscles to indicate that the disease is still active. But after the advent of suppuration the tenderness in the right iliac fossa usually becomes exquisite, and the tender area increases in size with the extension of the abscess.

Rigidity of the abdominal wall, next to pain and tenderness, is the most reliable sign of appendicitis. This is usually confined to the right lower abdominal quadrant, and develops immediately the pain is localized to this region. It varies in degree in different cases, but is generally well marked, and is most intense over the site of the inflamed appendix. In some instances the rigidity is so pronounced that it precludes palpation of either the appendix or a possible peri-appendicular abscess, and, in addition, gives to the percussion note a high pitch. When the pain has been referred to the left side, suppuration has supervened, and the pus collection occupies the pelvis, marked bilateral rigidity of the recti muscles and of the lower portion of the abdominal wall develops. When peritonitis becomes diffuse, rigidity of the entire abdominal wall occurs.

Although the three cardinal symptoms are the most important indications of acute appendicitis, there are other clinical manifestations that present themselves with more or less regularity, and that are of value in the diagnosis. Of these, there should be noted: disturbances of the gastro-intestinal tract, elevation of the temperature, disturbances of the cardiac and respiratory rhythm, abnormalities of the urine, etc.

Vomiting is a more or less constant symptom of acute appendicitis. It often occurs coincidentally with the onset of the initial pain, and may occur only once. In favorable cases it usually does not persist, but rather subsides with the localization of the pain in the right iliac fossa. In the event of suppuration it is likely to persist some time, and in unfavorable cases it may be continuous and uncontrollable. The vomited matter consists first of the gastric contents, then of bile or bile-stained fluid, and, finally, if septic peritonitis with consequent intestinal paresis have developed, of stercoraceous matter. When the vomiting becomes stercoraceous, the matter is thrown off by intestinal regurgitation, and often presages a fatal termination. The vomiting is sometimes attended by nausea, but both may be absent. Hiccup is sometimes observed, especially if the appendix point north and peritonitis has developed; more particularly, however, if the diaphragmatic peritoneum be involved.

The condition of the bowels varies in different cases. In the majority of cases constipation is observed. Diarrhea, however, sometimes ushers in the attack, particularly in those cases in which the initial pain is intense and which appear unfavorable from the start. In 341 of my own cases constipation was observed in 249, diarrhea in 42, alternate constipation and diarrhea in 11, and in 39 the bowels were normal. Obstinate constipation occurring early in the course of the disease is due to intestinal paresis the result of infection, to reflex paralysis of the bowel, or to the pernicious indiscriminate administration of opium. Neither constipation nor diarrhea seem to play much part in the causation of appendicitis, as in the majority of cases, prior to the onset of the attack, the bowels have been normal. As soon, however, as appendicular infection takes place there results a disturbance of the normal movement of the intestine, and constipation usually results. The latter is thus a symptom, not a cause, of the disease. The occurrence of this constipation, in association with vomiting and acute abdominal pain, in one previously healthy has led to many errors in diagnosis—inflammation of the appendix being mistaken for acute strangulation of the bowel or some other form of intestinal obstruction. The constipation may not develop at the onset of the attack. For several days the bowels may be normal, or there may be diarrhea, or alternate diarrhea and constipation. The definite occurrence of the latter may be postponed until the third, fourth, or fifth day, after which it may be most marked. If it persist from the commencement of the attack, or if it develop later and continue unrelieved, despite appropriate treatment, it usually indicates that the disease is most serious and will probably terminate fatally.

The temperature varies greatly in different cases of the same nature, and, in general, is a most unreliable factor in both diagnosis and prognosis. It certainly bears no direct relation to the gravity of the anatomic lesions. In what may be termed a typical attack of appendicitis there is usually moderate fever of short duration; that is, at the commencement of the attack there is generally fever that amounts to from 101° to 103° F., or more. The temperature usually rises rapidly, but sometimes rather slowly, and remains above 101° F. for one, two, or more days, after which the morning temperature is often normal. Subsequently, renewed elevations of temperature of varying degree may occur. These are probably not unconnected with new foci of infection or of absorption of bacterial products. It must not be presumed, however, that these latter always manifest themselves by elevations of temperature; they often occur without any rise of the temperature whatever. Indeed, the temperature often continues to approach the normal, or, having reached normal, remains so, despite the development of severe complications. In some cases there occurs but a moderate elevation of the temperature, which does not persist more than a few days. A few cases have been reported in which there has been no fever from the commencement to the termination of the attack; but these are most exceptional. Coincident with the development of a peri-appendicular abscess there is usually a rise of the temperature; in some such cases, however, the temperature remains stationary or falls. There may be early perforation or gangrene of the appendix and peri-appendicular abscess with but moderate rise of the temperature; on the other hand, there may be a decided rise of temperature with simple catarrhal appendicitis. A sudden fall of the temperature to the normal or subnormal by no means warrants a favorable prognosis. Indeed, in a great number of cases such fall in reality indicates the lull preceding the storm of destruction—perforation of the appendix or rupture of a circumscribed abscess. With the development of certain complications—such as general peritonitis, septic phlebitis, abscess of the liver, pyemia, etc.—the temperature almost invariably rises, and often reaches a high point, 104° or 105° F. It may continue high, with remissions, and become decidedly hectic. There are, finally, some cases in which the temperature continues high from the commencement to the termination of the attack. Such cases may end in recovery, though they are much more likely to terminate fatally. The temperature is thus a most unreliable aid in both diagnosis and prognosis. It bears no relation whatever to the seriousness of the anatomic lesions, but is rather the expression of the reaction and the resistance of the individual to the virulence of the infection, and it fluctuates with the variations of these factors.

The rate of the pulse bears no relation to the gravity of the attack of appendicitis. It may be slow or it may be rapid, and, in general, what has been said concerning the temperature applies with equal force to the pulse-rate. The character of the pulse, however, is of considerable value with reference to the gravity of the attack and the prognosis. If the pulse be strong, of good volume, regular, and the rate proportionate to the temperature, the outlook is favorable. If, on the other hand, the pulse be rapid, disproportionate to the temperature, of poor volume, irregular, and weak, the outlook is most unfavorable. In general, the pulse is a much better index of the gravity of the attack than the temperature.

Variations in the respiration play a comparatively unimportant part in the symptomatology of most cases of appendicitis. Early in the attack there is usually voluntary limitation of the respiratory excursions, the patient favoring costal breathing. If abdominal distention be pronounced, respiration is correspondingly embarrassed, while if there be diffuse peritonitis, the respiratory movements are almost exclusively costal. Very rapid respiration is often a manifestation of toxemia. In some such cases the breathing is excessively rapid, under which circumstances it often indicates some pulmonary complication, and usually presages a fatal termination. In advanced cases there is often noticeable a peculiar reflex condition of the pharynx that is described by the patient as a difficulty in swallowing.

Chills are of rather uncommon occurrence in appendicitis. Those that do occur are mostly of nervous or reflex origin. If, however, at the onset of the attack they occur in rapid succession, and are accompanied with high temperature, they indicate rapidly developing gangrene of the appendix. I have seen several cases in which the patient, previously well, was suddenly attacked with acute abdominal pain, severe chill, and high fever, followed by profuse sweating—the attack in all respects resembling a malarial paroxysm. At the operation, undertaken within forty-eight hours, the appendix was found gangrenous. The opinion commonly entertained that the development of peri-appendicular abscess is attended with chills is fallacious. The formation of such abscess is but rarely accompanied by chills or even by chilly sensations. It is much to be regretted that the erroneous opinion that the development of peri-appendicular suppuration is indicated by the occurrence of chills obtains, as the physician, awaiting such chills, is often deterred from regarding the proper treatment of a case of appendicitis as operative until a large fluctuating mass has formed. Chills occurring on the second or third day of the attack and associated with high fever usually indicate the development of metastatic or embolic abscesses.

The general condition of the patient varies in different instances. In the early hours of the attack there is the general facial expression of pain and considerable anxiety. Later, with the moderation of the pain, the patient remains quiet in bed and favors the right side. A characteristic posture is usually assumed in that the patient prefers the dorsal decubitus, inclines the body somewhat to the right, flexes the right thigh, keeps the left thigh prone, demands perfect quiet, and resents disturbance in the desire not to provoke or to intensify the pain. Aside from the general expression of pain and anxiety in the early hours of the attack, the facial expression is seldom indicative of serious disease. As the lesions become more wide-spread and peri-appendicular abscess and general peritonitis develop, the expression becomes more anxious, and a peculiar serious cast of countenance supervenes—facies abdominalis. In severe cases slight cyanosis and profuse perspiration sometimes occur. When the disease is somewhat advanced, restlessness may develop. This, if marked, particularly in children, is indicative of severe infection, of the probable presence of pus, and is a very unfavorable symptom. The tongue is usually furred; if diffuse peritonitis occur, the tongue may become dry, and sordes may collect upon the gums and teeth. In severe cases the tongue may become fissured. If there occur a sudden perforation of the appendix or a rupture of an appendicular empyema or peri-appendicular abscess, the severe pain may suddenly remit, the temperature fall, the pulse-rate increase, a marked pallor, profuse perspiration, and a most anxious facial expression supervene.

The foregoing are the most noteworthy symptoms of acute appendicitis; the diagnosis of the condition, however, is much facilitated by a thorough physical examination of the patient. This should be done systematically, by inspection, palpation, percussion, and auscultation.

The result of inspection of the abdomen in the majority of cases is completely negative. In a small proportion of cases, however, there will be detected a greater or less bulging of the right iliac fossa. In the early stages of the attack this is uncommon; in the later stages it may be due to a peri-appendicular abscess: it is rarely due to a nonsuppurative inflammatory exudate and serous infiltration of the abdominal wall.

A general distention of the abdomen is not infrequently observed, and may be due to one of several causes: To mechanical obstruction of the bowel, the consequence of the constricting action of bands of adhesion; to paralysis of the intestine, the result of septic infection, of the use of opium, etc.; to obstinate constipation with resultant accumulation of putrefactive gases, etc. In a few cases there develop on the first day of the attack, as a consequence of general irritation of the peritoneum, a general distention and some diffuse tenderness of the abdomen. But these usually subside rapidly. Richardson points out that it is possible, by means of auscultation, to distinguish between the distention due to accumulated gas and that due to paralysis of the intestine the consequence of infection; the sounds of the peristaltic action of the bowel are clearly audible in the former condition, but are absent in the latter. Distention, though usually general, may sometimes be limited to the right side of the abdomen, as a result of that portion of the bowel contiguous to the inflamed area alone being affected. This local distention may, upon occasion, become marked, by reason of the still functionating intestine forcing a greater or less quantity of gas into the affected portion. As is to be expected, the distention is most marked when the peritonitis is diffuse. In some cases of diffuse peritonitis, however, though the intestines are more or less distended, the abdomen may be quite flat and its wall rigid and hard. Under such circumstances there often arise most unpleasant symptoms the consequence of pressure from below upward upon the thoracic organs. Marked distention of the abdomen, particularly of the epigastric region, associated with persistent and uncontrollable nausea and vomiting, presages a fatal termination.

By palpation, in the early stages of an acute attack, we are usually unable to detect more than tenderness in the right iliac region—of which mention has already been made when discussing the three cardinal symptoms of the disease. In some cases, however, we can recognize by rather deep palpation a sense of resistance, which is sometimes distinctly circumscribed and of elongated, cylindric outline. This may with reason be ascribed to a thickened appendix and some possible peri-appendicular exudate of a nonsuppurative nature. In some cases such is the tenderness over the region of the appendix that even moderately deep palpation is impossible. In other cases the rigidity of the abdominal wall precludes satisfactory palpation.

On the other hand, in addition to tenderness and rigidity of the abdominal muscles, palpation may reveal a rather diffuse resistance or a more or less distinctly circumscribed swelling or tumor in the right iliac region. The tumor, when palpable, is of smooth or roundish contour, and its edges are usually sloping. It varies in size in different cases. It is sometimes no larger than an egg; it is usually as large as a lemon or small orange; it is rarely as large as a cocoanut. It generally courses parallel with Poupart's ligament and is removed a short distance from the crest of the ilium. When large, however, it may reach the ilium, and may extend upward beyond its crest and beyond the median line of the abdomen. The tumor in the vast majority of cases is immobile. It is generally firm, but may be quite soft; in some cases, particularly if it be large, it may present distinct fluctuation.

The conditions upon which this tumor or swelling depends vary somewhat in different instances. In cases unattended by peri-appendicular suppuration it is due to the thickening and edema of the inflamed tissues—the wall of the appendix, and possibly the cecum and the omentum; to peri-appendicular serous, sero-fibrinous, and fibrinous exudate; to inflammatory alterations not only of the visceral, but also of the parietal peritoneum of the iliac fossa and the abdominal wall; and in some cases to serous and cellular infiltration of the transversalis fascia and the abdominal muscles. In the majority of these cases the size of the swelling is usually dependent upon the amount of the peri-appendicular exudate, which at times is excessive. In endeavoring to formulate an opinion as to the cause of a swelling in an individual case it must be borne in mind that the plastic exudate surrounding an inflamed appendix may be 3 cm., 4 cm., or 5 cm. in thickness. As a consequence, it must not be assumed that all tumors, even if they be of moderate size, have within them a purulent focus. Some even very large swellings develop with such rapidity and become so quickly dissipated that it is impossible to hold with reason that they have been suppurative. Such exudates, however, are very prone to become purulent, and it is true that all tumors of moderate and large size are, in part at least, composed of pus. It is, of course, in cases in which there is a considerable quantity of pus that fluctuation may be elicited.

The consideration of this swelling naturally leads to a discussion of the question of stercoral typhlitis. That the condition formerly referred to as typhlitis is not typhlitis, but appendicitis, is stated elsewhere. That stercoral typhlitis—an inflammatory condition of the cecum the consequence of the irritant action of feces retained within it without extrinsic cause—does not occur is equally true, and must be evident to all who have had experience. In discussing this question, Sahli aptly remarks that "anything under the sun may exceptionally occur once." That stercoral typhlitis may occur can not be denied; the assertion that it does occur is not based upon any sound evidence found at either operation or necropsy. By some a series of cases presenting pain, tenderness, and a more or less soft tumor in the right iliac fossa, constipation, slight fever, etc., have been recognized as stercoral typhlitis—not that any one has ever described the anatomic lesions of stercoral typhlitis, but solely upon clinical assumption. It is in such cases that early operation has demonstrated the presence of catarrhal and interstitial appendicitis with serous or fibrinous peritonitis. The cecum, in such cases, but rarely reveals evidence of disease, and such as does exceptionally occur is always less marked than is that of the appendix. In the event of coprostasis the cecum is by no means the seat of predilection of such stagnating feces. Feces are commonly found in the colon, but they are rather unusually encountered in the cecum, and such as are detected in the cecum are always much softer than those elsewhere in the colon—as is to be expected from the close proximity of the cecum to the ileum. In my operative experience, which is now considerable, I have never encountered any fecal stagnation in the cecum. If fecal stagnation be the cause of inflammation of the intestine, we would naturally expect the descending colon and the sigmoid flexure to be frequently the seat of such disease. Fecal tumors that are palpable during life are never encountered in the region of the cecum. Fecal impaction, when it does occur in the cecum, from causes such as stricture of the bowel, etc., does not give rise to the symptoms ascribed to stercoral typhlitis. The absence in extensive necropsy records of any mention of fecal stagnation in the cecum is evidence that a condition that is not encountered at operation is not observed after death. Clinically, there is found to be gradual progression in the severity of the symptoms of those cases recognized by some as stercoral typhlitis to those with unmistakable evidence of serious appendicular lesions and circumscribed and diffuse peritonitis. The occurrence of ulceration and perforation of the cecum with peri-cecal suppuration, even in the absence of perforation of the appendix, can not be considered *prima facie* evidence that the perforation of the cecum occurred from within outward and that the peri-cecal suppuration is the consequence of primary disease of the cecum. In such cases the sequence of events is as follows: There first occurs an inflammation of the appendix, which is usually attended by ulceration, but which may not go on to perforation. There then develops a peri-appendicular abscess, the reasons for which are explained in the chapter on the pathology of the affection. This finally ruptures *into* the cecum, an occurrence which presents its anatomic proofs in the greater destruction of tissue at the serous, not the mucous, coat. Other cases of perforation of the cecum are the result of the rupture directly into the cecum of an appendix that has formed adhesions with it. That perforation of the cecum the consequence of a primary typhlitis does not occur is indicated by the statistics of Einhorn, who found that among 18,000 necropsies, the very few cases of primary perforation encountered were all in cases of intestinal stenosis. That stercoral typhlitis may occur I will not deny; that it does occur, I do not believe.

Percussion is of subordinate importance in the diagnosis. In the event of a swelling or tumor in the right iliac fossa the note is generally dull and high in pitch. Such note may, however, be due to causes other than appendicitis with peri-appendicular peritonitis, and these morbid conditions may develop without the occurrence of dullness on percussion. Even large peri-appendicular abscesses may exist with a tympanitic note in the right iliac fossa. Such note will occur, for instance, if a coil of intestine overlie the abscess. A dull note, of tympanitic quality and high in pitch, may occur in the absence of an abscess if there be excessive rigidity of the abdominal wall. At times there is found an area of tympany intervening between the ilium and the area of dullness. This is generally due to the presence in this region of the cecum—the abscess being situated medianly.

Auscultation reveals little of importance in the diagnosis. Reference has already been made to its value in distinguishing between distention due to accumulated intestinal gas and that due to paralysis of the intestine the consequence of infection. Mannaberg and Nothnagel have drawn attention to an accentuation of the second pulmonic sound of the heart in appendicitis; but the cause of the phenomenon has not been explained. Auscultatory percussion by means of the stethoscope or phonendoscope may assist in the delimitation of the tumor.

From the commencement of certain attacks of appendicitis frequency of urination is often a prominent symptom. In certain cases this is doubtless due to disturbances of the sympathetic nervous system; in others,—those in which the inflamed appendix occupies the pelvis,—to an irritation communicated directly to the bladder. In peritonitis involving the serous coat of the bladder retention of urine, necessitating catherization, may occur. The urine is usually diminished in amount, of high specific gravity, dark in color, and often contains albumin, casts, and an increased amount of urobilin and indican. These alterations are due in part to the fever usually present at the commencement of the attack, but particularly to the direct action on the kidneys of the toxin of the bacteria concerned in the production of the appendicitis. Of the excessive virulence of this toxin in many cases sufficient experimental proof has already been adduced. Its action on the human organism is to produce parenchymatous degeneration of the tissues, especially of the liver, heart, kidney, etc. In the kidney it produces acute and subacute toxic nephritis. I have records of numerous cases in which the urine was less in amount than normal, and contained erythrocytes, leukocytes, hyaline, granular, and epithelial casts, desquamated epithelium, granular debris, etc. In most of these cases the urine returned to the normal condition during convalescence, and such may be expected in favorable cases.

Leukocytosis has been observed in a number of cases of appendicitis. Its value as regards diagnosis, prognosis, and indication to operation is insignificant. Its presence or absence is no index to the nature or extent of the lesions of the appendix. A marked leukocytosis (above 20,000 to the cubic millimeter of blood) is indicative of suppurative peritonitis, which may be either circumscribed or diffuse; but either or both of the latter may occur without leukocytosis. This, however, is of very grave prognostic significance.

CHRONIC APPENDICITIS.

Chronic appendicitis may develop in one of several ways. It may commence insidiously, with indefinite and vague symptoms, so that the patient is unable to designate any stated time as the date of the beginning of his illness. It may follow a more or less frank attack of acute appendicitis from which the patient recovered by medicinal treatment or by surgical treatment, the appendix, however, not being removed. In certain cases of the second variety the acute attack is partly recovered from, but the patient does not entirely regain his former health, and attacks of acute exacerbation occur from time to time. This is known as *relapsing appendicitis*. In other cases the patient apparently recovers his former health, and at long intervals—six months, a year, or more—other attacks occur. This is known as *recurring appendicitis*. That recurrences are very frequent is indicated by various statistics. Thus Nothnagel gives the percentage of recurrences in his experience as 16 per cent.; Rotter as 21 per cent.; Sonnenburg as 32 per cent.; and Sahli, from a collective investigation of 4593 cases from private practice, as 20.8 per cent. Of 460 of my own cases, recurrences were noted in 312 (67.8 per cent.). The vast majority of recurrences develop within the first six months; there are less within the succeeding six months. During the following years the likelihood of recurrence becomes gradually less; recurrence may nevertheless occur after a great number of years. The number of recurrences that a patient may suffer is variable. Of the 312 patients previously referred to, 89 had two attacks, 52 had three attacks, 30 had four attacks, 18 had five attacks, 16 had six attacks, 6 had seven attacks, 2 had eight attacks, 2 had nine attacks, 4 had ten attacks, 1 had twelve attacks, 2 had sixteen attacks, 2 had twenty attacks. The number of attacks that the remainder had is not known.

The symptoms of chronic appendicitis are most variable. The most constant of all is pain, which is usually confined to the right iliac fossa. It is of slight or moderate intensity, often persistent, and subject to acute exacerbations of minor intensity. The pain is increased by blows in the region of the appendix, by sudden exertion or undue exercise, and by the presence in the intestinal tract of indigestible food, which, by exciting increased peristalsis, leads to traction upon the peritoneal adhesions. The acute attacks are often of marked severity, incapacitating the patient for work and confining him to bed. At times the acute lesions may progress to ulceration and perforation of the appendix, with the development of a peri-appendicular abscess or diffuse peritonitis. The symptoms of such attacks are those described in connection with acute appendicitis. At other times the acute exacerbations are relatively inconspicuous, and the pain is more or less dull and of unvarying intensity. One of my patients had constant pain for fifteen years.

Associated with the pain there is sometimes general debility and indisposition for work or exertion of any kind. There are often the indications of intestinal indigestion—abdominal fullness and distress, tympanites, borborygmi, coated tongue, capricious appetite, mucous diarrhea with alternate constipation, headache, malaise, hypochondriasis, etc. Neurasthenia is frequently a concomitant condition. Fever is usually absent. When present, it is of importance only when of the hectic type.

Palpation reveals more or less tenderness in the right iliac region. At times, even in the absence of much pain, the tenderness may be exquisite. In the majority of cases, if the tenderness be not prohibitive of deep palpation, an enlarged and thickened appendix can be made out. At times this can be rolled beneath the palpating finger as an indurated cylindric mass. If there be much exudate and adhesions, and especially if the omentum be adherent to the appendix, a distinct mass of rather large dimensions can be demonstrated by palpation. Not infrequently palpation of a chronically inflamed, semi-quiescent appendix excites an acute exacerbation of the inflammation. This is especially likely to be the case if the appendix contain a focus of pus. If the latter be present, tenderness on palpation is also likely to be more marked than when it is absent.

The danger attendant upon these chronic cases is their tendency to develop suddenly an acute exacerbation, which may go on to ulceration, perforation, gangrene, circumscribed or diffuse peritonitis, etc.

SUMMARY.

There is no constant relationship between the symptomatology and the pathologic alterations.

Of acute appendicitis there are "three cardinal symptoms" —pain, tenderness, and rigidity of the abdominal wall.

The pain usually develops after eating. At first it is colicky, and is referred to the epigastrium; later, it becomes localized at the site of the appendix.

Tenderness on pressure is always present, and is sometimes best elicited by rectal or vaginal examination. The point of greatest tenderness is usually over the site of the appendix.

The rigidity of the abdominal wall is usually right-sided. It follows the localization of the pain, and is most marked over the inflamed area.

Vomiting is common at the onset of the attack. It desists in favorable cases. Its continuance is an unfavorable symptom.

In chronic appendicitis the history is important. Localized pain and tenderness are the most constant symptoms. Palpation is a most valuable means of diagnosis.

DIAGNOSIS.

The diagnosis of appendicitis is ordinarily unattended by special difficulties. When there are present the three cardinal symptoms of the disease,—that is, sudden onset of acute abdominal pain, with or without vomiting, occurring in one previously well; unilateral rigidity of the right lower abdominal wall; tenderness over the site of the appendix,—the diagnosis of appendicitis is warranted in the majority of cases. That the diagnosis is not always made is due to several causes, of which the most important are the persisting belief in a primary typhlitis, the nonappreciation of the frequency and the seriousness of appendicitis, and the all too common habit of speaking of gastro-intestinal disorders attended by pain, nausea, and vomiting, as "inflammation of the bowels." Happily, the idea of a primary typhlitis is being dissipated, but there still lingers in the minds of many the idea of an inflamed cecum filled with fecal matter and a consequent inflammation of the surrounding connective tissues—para-typhlitis. By some the appendix is still disregarded. If from this mental picture the cecum could be entirely obliterated, and in its stead an inflamed appendix substituted, mistakes in diagnosis would be of less common occurrence. A conscientious effort to differentiate the various conditions grouped by some under the generic term "inflammation of the bowels," and an appreciation of the frequency and seriousness of appendicitis, which must be evident to all acquainted with the pathology of the affection, will tend further to decrease the number of diagnostic errors.

Failures in diagnosis may often be explained by the fact that the initial symptoms have been lost sight of, or have been concealed by the injudicious use of opium. The commencement of an attack of appendicitis very closely simulates acute indigestion, in that there occur vomiting, colicky pains, often implicating the entire abdomen, and tenderness. In appendicitis the nausea and vomiting usually occur after the acute abdominal pain, whereas in acute indigestion this is not always the case. In appendicitis, also, the general abdominal pain soon becomes localized in the right iliac fossa, which fact should at once lead to the supposition of more serious trouble than simple indigestion. Although the pain is usually localized in the right iliac fossa, the fact should not be lost sight of that it varies somewhat with the position of the appendix. As already noted in the symptomatology, if the appendix point north, the pain may be referred to the lumbar or hepatic region. In certain cases it is referred exclusively to the left side. In some of these cases the appendix points east, but commonly south and occupies the pelvis. This latter fact must be emphasized, as I have seen a number of cases in which the attending physicians, who were familiar with the general symptoms of appendicitis, were totally misled by the reference of the pain to the left side. The citation of one case, that of the son of a physician, will serve to illustrate the importance of pain referred to the left side as indicative of the pelvic position of the appendix:

Master A., shortly after a meal of indigestible food, was suddenly seized with acute abdominal pain, vomiting, and rigidity of the right lower abdominal wall. Symptoms of acute peritonitis developed on the third day, whereupon the father consulted me, stating that he would have regarded the case as one of appendicitis had the pain not been referred to the left side. I told him that in my opinion the disease was appendicitis, and that immediate operation was demanded. Two days later, I was hastily summoned to see the boy, whom I found suffering from a diffuse peritonitis of an active type. He had a pulse-rate of 130 a minute, a "leaky" skin, was constantly retching, and had obstinate constipation. I declined to interfere except to advise discontinuance of opium and all its preparations. Instead, I ordered small repeated doses of calomel to the extent of securing free purgation, believing such medication wiser than operation, at that time. Apparent recovery followed. I then advised operation to prevent recurrence, but the father declined to have his son operated upon when in apparent good health. Within ten days a second attack occurred. I was again summoned, but being absent from home, other counsel was sought, and operation again deferred. Apparent recovery again ensued. Again I was consulted, and again advised operation, to which objection was no longer made. At operation the appendix, the tip of which contained a collection of pus, and the whole of which was surrounded by a circumscribed abscess, was found occupying the pelvis, adherent to its floor and to the right side of the rectum. The appendix was removed and an uneventful recovery followed.

It should be borne in mind that in those cases in which the pain is referred to the left side, and the point of greatest tenderness is immediately above the pubis or in the left iliac region, the appendix extends into the pelvis, and the greatest intensity of inflammation is at the tip of the organ. It is in this class of cases that vesical symptoms, such as irritability, frequent micturition, and retention of urine, are of value in the diagnosis.

The tenderness, which at the onset of an attack of appendicitis is sometimes diffuse, also usually becomes localized to the right iliac fossa, and the point of greatest tenderness, usually McBurney's point, generally corresponds with the position of the inflamed appendix. This tenderness is one of the most constant and valuable signs of appendicitis. It may be elicited in many cases by slight pressure of the tip of one finger. In some cases of suspected appendicitis palpation of the abdominal wall will reveal but moderate tenderness; the point of greatest tenderness being detected by vaginal or rectal examination.

In acute cases it is usually not at all difficult to elicit tenderness. When asked to locate the point of greatest tenderness, the patient himself will almost invariably direct attention to the site of the appendix. Palpation over the indicated region will reveal marked tenderness, and may provoke wave-like exacerbations of pain. In chronic cases it is more difficult to locate tenderness, but deep pressure will rarely fail to provoke pain and tenderness, and may reveal a thickened organ. In practising this palpation care must be exercised not to mistake any of the following for a thickened appendix: The outer border of the rectus muscle, the semilunar aponeurosis, the inner border of the internal oblique and transversalis muscle, and the anterior crural nerve coursing along the outer border of the psoas muscle. Assistance may be had by comparing the conditions upon the opposite side of the body.

There is usually a close relationship between the degree of tenderness and the degree of the progress of the disease. As a rule, increase of tenderness denotes progression of the inflammatory lesions, while decrease of tenderness occurring without the administration of anodynes generally indicates subsidence of the inflammation. If pus be present, the tenderness is usually exquisite. If, however, septic absorption has progressed to such an extent that paralysis of the nerve filaments has ensued, there may be little or no tenderness without abatement of the disease. Under such circumstances the other signs of appendicitis are so evident that no error in the diagnosis should occur. The appendix is usually less tender if the pus be confined within the appendix than it is if it be peri-appendicular. It is most marked in any peri-appendicular suppurative peritonitis, whether it owe its origin to ulceration, with or without perforation, to gangrene of the appendix, etc. In general peritonitis the tenderness is wide-spread.

The rigidity of the abdominal muscles is usually evident upon gentle pressure. In the majority of cases it is confined to the right side; at times, if the pain be referred to the left side, the rigidity is more pronounced upon that side. If the diseased appendix and a consequent peri-appendicular abscess occupy the pelvis, the abdominal rigidity will be bilateral, as is illustrated by the following case:

Miss ——, about two weeks prior to my first visit, was suddenly attacked by what at first seemed to be acute indigestion. It did not yield to ordinary medication. In view of the fact that the spleen was enlarged, spots were present upon the abdomen, and the temperature was irregular, a provisional diagnosis of typhoid fever was made. On the other hand, the suddenness of the onset of the affection, the acute abdominal pain, the decided bilateral rigidity of the lower abdominal wall, the irregular temperature, the great pain produced by rectal and vaginal examination, and the characteristic fullness of the pelvis rather indicated appendicitis with a large collection of pus in the pelvis. I advised immediate operation, but adverse opinion of other counsel caused postponement for two days. Operation disclosed a large collection of malodorous pus and the appendix, which was perforated, occupying the pelvis. The abscess was evacuated, the appendix removed, and an uneventful recovery ensued.

A careful consideration of the nature and cause of the local distention is sometimes demanded. This fullness, as has already been stated, may be due to peri-appendicular peritonitis and to inflammatory lesions—serous and cellular infiltration—of the abdominal wall. In certain cases the edema of the abdominal wall, associated with symptoms of another disease, may lead to the false impression that the affection is not appendicitis, as is illustrated by the following instance:

Miss H. became ill ten days prior to my examination. She had presented the usual manifestations of acute appendicitis, but owing to slight jaundice and decided edema of the tissues overlying the hepatic region and the lower right chest, there was some doubt in the mind of the attending physician as to the location of the inflammatory process. Upon pressure there was more pain over the edematous area than over the usual site of the appendix. From a review of the symptoms of the patient from the onset of the attack, however, I concluded that the case was one of suppurative appendicitis, and that the organ pointed north and was located post-cecal. Operation confirmed the correctness of these views. The appendix, gangrenous and separated from the cecum, was post-cecal and surrounded by a collection of pus which extended behind the liver and inward to the vertebral column. Recovery ensued.

The occurrence of gangrene of the appendix is indicated by sudden cessation of the pain previously localized in the region of the appendix, fall of the temperature, increased pulse-rate, anxious facial expression, and more or less profuse perspiration. The diagnosis of peri-appendicular suppuration is warranted when, with the history of the ordinary initial manifestations of appendicitis, there are present continuous fever and a tumor, which is exquisitely tender on pressure. If the tumor fluctuate, the diagnosis is rendered more certain.

Serum Diagnosis.—Acting upon the assumption that the bacterium coli commune is the predominant factor in the bacterial origin of most cases of appendicitis, and that the general symptoms of the disease are, at least in great part, due to the toxin of this bacterium, some investigations bearing upon the applicability of the Widal test with this bacterium were undertaken in the Pathologic Institute of the German Hospital. It was hoped that this test might prove of some value in the diagnosis of the disease, more particularly in obscure cases, or that it might furnish a clew to the identity of the causative bacteria or to the severity of the infection in individual cases. No definite results were, however, obtained.

Nevertheless it is not denied that extensive series of such investigations may lead to some noteworthy scientific and practical consequences.

SUMMARY.

In the diagnosis the three cardinal symptoms are most important:

1. Sudden acute abdominal pain in one previously well.
2. Unilateral rigidity of the lower abdominal wall.
3. Tenderness over the site of the appendix.

Soon after the onset of the attack the tenderness on pressure becomes localized, and its intensity is a fair guide to the intensity of the lesions of the appendix and peritoneum. The area of greatest tenderness is usually at McBurney's point, but it varies with the position and condition of the appendix.

Rectal or vaginal examination or both should generally be made, but especially in those cases in which abdominal palpation yields negative results. In these cases rectal and vaginal examinations demonstrate points of marked tenderness, sometimes fullness, and are of the greatest value when the appendix points south.

Tenderness is increased in:

1. Pus formation.
2. Gangrene of the appendix.
3. Perforation of the appendix.

Tenderness is decreased:

1. After discharge from the appendix of an appendicular calculus.
2. After free evacuation of the bowels.
3. Late in suppurative cases when sufficient toxins have been absorbed to paralyze the peripheral nerve filaments.

Abrupt cessation of pain indicates complete gangrene.

Pain and tenderness on the left side indicate that the appendix points south (rarely east) and occupies the pelvis. In these cases vesical symptoms are common.

Pain on the left side with tenderness over the pubis indicates that the appendix points south and that the tip of the organ alone is involved or that it is the seat of the most intense inflammation.

Pain on the left side with bilateral rigidity indicates that the appendix points south and that a collection of pus surrounds it.

Pain over the hepatic or the right renal region with tenderness over the course of the ascending colon indicates that the appendix is either post-colic or post-cecal and post-colic and that it points north.

Fullness appears late—after the development of an inflammatory mass or the occurrence of suppurative peritonitis.

Excessive tenderness is the most reliable sign of pus.

Distention:

1. Localized—is due to localized peritonitis.
2. General—is due to:
   (*a*) Constipation.
   (*b*) The administration of opium.
   (*c*) Paralysis of the intestines the consequence of sepsis.
   (*d*) Mechanical intestinal obstruction.
   (*e*) General peritonitis.

A chill denoting pus formation is rare.

The detection of a tumor is often impossible on account of the tenderness and rigidity. When adhesions and infiltration are present, a tumor can usually be detected. Rectal examination is often successful in determining the presence of a tumor or fullness when abdominal palpation is entirely negative.

DIFFERENTIAL DIAGNOSIS.

While in the majority of cases the recognition of appendicitis is not especially difficult, there are, nevertheless, some affections that in many respects so closely simulate it as to give rise to perplexities in the endeavor to discriminate between them. Of these, the most important are various disorders of the gastro-intestinal tract, particularly typhoid fever and other morbid conditions attended by ulceration and possible perforation of the bowel; disturbances of the gall-bladder; and, especially in the female, disease of the genito-urinary organs. There are, in addition, other rarer conditions which engender difficulties in the effort to establish a differential diagnosis, and which, in consequence, demand consideration.

ACUTE INDIGESTION.

An attack of acute indigestion resembles an attack of acute appendicitis in that in both there is a history of the ingestion of indigestible food, pain in the epigastric and umbilical regions, nausea, vomiting, and fever. Such is the resemblance between these two affections that many cases of acute appendicitis have been given, and are still given, slight attention, under the misapprehension that they are cases of acute indigestion. The latter condition, however, in contradistinction to acute appendicitis, never gives rise to rigidity of the right lower quadrant of the abdominal wall, to tenderness on pressure in the right iliac fossa, nor does the pain become localized in the region of the appendix. Further, if the symptoms be due to acute indigestion, abstinence from all food and the prompt administration of a calomel purge, with evacuation of the bowels, will be followed by subsidence of the manifestations.

A very common cause for the confounding of these two affections is the unwise administration of an opiate for the relief of pain. In the case of an adult suffering from acute abdominal pain the drug most commonly administered is, I regret to state, morphin hypodermically. Morphin undoubtedly arrests the pain, but in doing so it also obscures symptoms which otherwise would serve as danger-signals. As a result of this injudicious course the physician is too often mortified to discover that the case which he originally regarded as one of simple indigestion was in reality one of acute appendicitis. I have no hesitation in stating that many human lives are being daily sacrificed to the pernicious practice of administering morphin instead of purgatives in cases of acute abdominal affections, and in mistaking cases of appendicitis for acute indigestion, biliousness, gastritis, or inflammation of the bowel.

In many cases of children attacked by acute abdominal pain and vomiting the household remedy administered, or that obtained by messenger from the nearby druggist, is commonly some cholera or diarrhea mixture, or some secret nostrum the chief ingredient of which is probably some preparation of opium. This is equally as pernicious as a hypodermic injection of morphin. It serves well to lessen the chances of establishing a diagnosis early between acute indigestion and acute appendicitis.

BILIOUSNESS, OR ACUTE GASTRO-DUODENAL CATARRH.

Biliousness, or acute gastro-duodenal catarrh, is usually manifested by pain in the epigastrium, nausea, vomiting of food, which later may be mixed with bile, moderate fever, and constipation. At times there may be a slight icteric tint to the skin and conjunctivæ. All patients who complain of "bilious attacks," acute indigestion, or cramp-like pains in the abdomen should be examined for appendicitis. Acute gastro-duodenal catarrh is differentiated from acute appendicitis by the fact that in the former the pain does not become localized in the right iliac fossa, that there is no rigidity of the abdominal wall in the right lower quadrant, and that pressure over the appendix does not elicit tenderness. As in acute indigestion, fractional doses of calomel and entire abstinence from food usually suffice to establish a cure. The two conditions may be further differentiated by the fact that the symptoms of acute indigestion and gastro-duodenal catarrh are not progressive if treated rationally, while those of acute appendicitis are.

INTESTINAL COLIC.

The fact that an attack of acute appendicitis is ushered in by abdominal colic may in some instances lead to the physician's confounding the case with one of ordinary intestinal colic or enteralgia. At the onset both affections much resemble each other, but the colic in appendicitis grows more intense with each succeeding return of the pain, and the attacks are wave-like in character. In the event of either affection, the patient usually assumes the recumbent posture and flexes the thighs upon the abdomen. He complains of nausea, and may have vomited. In appendicitis there are present the three cardinal symptoms—pain, tenderness, and rigidity; in ordinary enteralgia there is colicky pain, but no tenderness. On the contrary, the pain is relieved by pressure over the umbilical region —to which the pain is referred. In exceptional cases of appendicitis the pain may be referred to the umbilical region. These are cases in which the appendix holds an easterly direction. Under such circumstances pressure in the umbilical region—that is, over the diseased appendix—increases the pain, reveals tenderness, and may aggravate the nausea. Other unusual positions that the appendix may assume should be borne in mind, and diligent search should be made for points of tenderness in the endeavor to establish the correct diagnosis.

The duration of an attack of intestinal colic depends upon the provoking cause, and often subsides under any rational treatment. An attack of acute appendicitis, on the other hand, usually progresses rapidly, and grave symptoms may manifest themselves early.

INTESTINAL OBSTRUCTION.

In intestinal obstruction the onset is more abrupt than in appendicitis. The pain, remittent in character and of a severe type, may be referred to the site of the obstruction, or, more commonly, to the umbilicus; in appendicitis the pain is not so severe, it is at first referred to the umbilicus, and later to the position of the appendix. In intestinal obstruction there are absolute constipation and inability to pass flatus; persistent and uncontrollable vomiting occurs early and soon becomes fecal. In appendicitis constipation is not absolute, diarrhea may be present, and the vomiting ceases after the stomach is emptied. In intestinal obstruction the temperature and pulse are normal or subnormal until the advent of peritonitis. In appendicitis the temperature is above normal. With the onset of peritonitis in intestinal obstruction regurgitant vomiting begins. This soon becomes fecal—a condition which rarely occurs in appendicitis except in the later stages. Intussusception is the most common form of obstruction in children, while obstruction from bands and volvulus is more common in adult life. Tumors the result of such forms of obstruction are generally to the left of the linea alba. When obstruction is the result of intussusception, blood and mucus will be discharged from the rectum, and upon examination through this canal a tumor may be felt. The development of peritonitis in acute intestinal obstruction is marked by great abdominal distention. Shock and collapse appear early in obstruction. Such is not the case in appendicitis unless the attack be of the fulminating type, and even then collapse appears later.

Several cases of inflammation of Meckel's diverticulum, with resulting gangrene of the intestine simulating an attack of appendicitis, have been reported, but the condition is not possible of recognition clinically.

TYPHOID FEVER.

Differentiation between typhoid fever and appendicitis is a frequent source of diagnostic perplexity; so much so, indeed, that upon more than one occasion I have seen the surgeon forced to defer operation in appendicitis because the opinion of the majority of the medical attendants was that the disease was typhoid fever. Yet in the early stages of the two affections the characteristic symptoms are distinct. The sudden onset in one previously well, the rigidity of the right lower abdominal wall, and the tenderness limited to the position of the appendix are collectively almost pathognomonic of appendicitis. On the contrary, the slow onset, attended by lassitude, headache, epistaxis, a peculiar temperature record, diffuse abdominal tenderness, with relaxation of the abdominal walls, and an enlarged spleen, are distinctive of typhoid fever, and should be sufficient to establish a differential diagnosis with absolute certainty. If, in connection with these differential points, a digital examination of the rectum demonstrate a sensitive mass, any doubt of appendicular inflammation should be at once dispelled. Spots may be found, but they are not of absolute diagnostic value, since they may be present or absent in both affections. Typical roseola, however, in association with other signs and symptoms are most suggestive of typhoid fever.

Follicular abscesses of the appendix are responsible for some mistakes in the differential diagnosis between appendicitis and typhoid fever. The minuteness of the collections accounts for the mildness and the prolongation of the sepsis, and for the lessened degree of the local symptoms. In this type of appendicitis there are persistent elaboration and continuous absorption of infectious products, with a small amount of tissue involved. In many respects the temperature record and the general condition in such cases closely simulate irregular typhoid, and much care in examination is essential. It is not uncommon to find supposed typhoid fever cases in which operation has demonstrated the presence in the appendix of very small follicular abscesses varying in size from a millet-seed to a mustard-seed, an eroded mucous membrane, and a more or less infiltrated organ.

The points to be borne in mind in making a differential diagnosis between appendicitis and the later stages of typhoid fever are of sufficient distinctness, but each symptom must be conscientiously studied. The early history and the entirely local symptoms, on the one hand; the general abdominal and mental symptoms, with dry tongue, and the temperature record, on the other, are quite sufficient to make differentiation clear and distinct. The spleen is enlarged in both affections. The enlargement, however, due to septic infection from an active suppurative process such as appendicitis is likely to be associated with pain, the result of peri-splenitis. Difficulty, however, exists, and the following case is related to illustrate the fact that follicular abscesses in the appendix are capable of causing a train of symptoms which suggest typhoid fever:

Dr. M. consulted me about his little girl, the nature of whose illness was not clear to him. He related to me the history of the case and showed me the temperature record. I suggested that the symptoms resembled those of subacute appendicitis. An appointment was made with a physician, one of my assistants, and Dr. Frese, of the German Hospital. In consultation the following conditions were noted: There had been slight epistaxis about seven days previous to the date of the examination; the temperature record was irregular, dropping suddenly on the fifth day from 103° F. to normal; the tongue was dry and coated, with red borders, and while headache was present, the mental condition was quite clear. The spleen was somewhat enlarged, and on the abdomen, which was slightly tympanitic, were noticed some indistinct rose-colored spots. Only very careful questioning of the mother elicited the fact that the child had for several months been ailing with digestive troubles, which, never severe, had always yielded to a purgative dose of castor oil. Examination of the right iliac fossa demonstrated distinct tenderness and gurgling. No mass could be detected. One of the consulting physicians inclined to the diagnosis of typhoid fever, and advised delay. The two other consultants diagnosed appendicitis, basing their conclusion on the previous history, the absence of mental symptoms, and the distinct tenderness in the right iliac fossa. On the following day I saw the patient, and received permission to operate if I concurred in the diagnosis of appendicitis. This I did, and operated at once. The following conditions were found: The appendix was situated behind the colon, to which it was adherent; the mucous membrane lining the tip of the appendix, which was club-shaped, contained several follicular abscesses, the largest of which was the size of a split pea. Recovery was uninterrupted and rapid. The symptoms which had suggested typhoid fever disappeared immediately after the removal of the appendix.

In all doubtful cases, and when time is not an important element, the Widal test with the typhoid fever bacillus should be made. Although not absolutely conclusive, this test is of much value.

A condition that must be borne in mind in the differentiation of acute appendicitis from peritonitis the result of perforation other than that of the appendix itself is *perforating typhoid ulcer*. The history of typhoid fever, with the characteristic prodromal stage, the nervous manifestations, the enlarged spleen, the characteristic temperature, the presence of spots, and the sudden onset of acute general abdominal pain with general abdominal rigidity, would suggest perforating typhoid ulcer. A case in point is the following:

Dr. F., aged twenty-seven years, was admitted to the German Hospital on November 7, 1897. The diagnosis was enteric fever; perforative ulcer; free pus in the peritoneal cavity.

The family history was good, there being no history of tuberculosis or carcinoma. The patient had had la grippe six years ago, and typhoid fever ten years ago. Ten days before the patient was brought to the hospital he complained of malaise and loss of appetite. He would arise in the morning tired, and in the afternoon would feel worn out. He lived on milk and bread during this time. He complained of headache one week previous to admission. Bowels were rather constipated. He took aloin, belladonna, and strychnin pills almost every night. Two nights previous to admission his temperature was 102° F. (Only time that the temperature was taken by him.) The night previous to admission to the hospital, the patient partook of a meal consisting of sirloin steak, celery, bread and butter, coffee, a pear, and a peach. After eating dinner he went to his office, where a number of patients were waiting. He saw only one, when he was suddenly taken with severe abdominal pain, necessitating his going to bed. For this pain he took sulphate of magnesia, applied hot-water bottles to the abdomen, and drank freely of warm fluids. The pain in the abdomen was severe, requiring morphin. The following morning the entire abdomen was distended, very rigid, and exquisitely tender, especially over the lower right quadrant. I was called by Dr. Eckman in consultation, and after the examination we were convinced that there was serious intra-abdominal lesion, most probably slow leakage from a perforated typhoid ulcer, as indicated by the history and condition. We were, however, by no means certain that it was not a perforated appendix. I advised operation, emphasizing the fact that delay would be dangerous. Operation revealed a considerable quantity of pus, and free gas in the peritoneal cavity. The appendix was intensely congested, and was removed. No attempt was made to locate the perforation, on account of the difficulty experienced in dealing with the intestines, which were greatly distended, so that, notwithstanding the small incision and the use of gauze packing, etc., it was almost impossible to confine them to the peritoneal cavity. I therefore contented myself with thorough irrigation and drainage. The patient went through an attack of typhoid fever of a typical course and of the most severe type, being complicated by several hemorrhages. He was transferred to my medical colleague, Dr. J. C. Wilson, and eventually recovered. Microscopic examination of the excised appendix revealed ulceration of the mucous membrane lining the appendix.

GASTRIC ULCER.

Rarely, appendicitis and gastric ulcer may be confounded, especially when both have become chronic. In both the pain is similar in character and is increased by pressure. The location of the painful area in both varies, and is, therefore, not an absolute guide in differential diagnosis. Gastric disturbances are common to both. The mode of onset, however, differs in the two affections; gastric ulcer is usually of slow development, while even in chronic appendicitis a history of an abrupt onset can generally be obtained. In gastric ulcer the relief of nausea and pain by vomiting, the character of the vomited matter, which is frequently streaked with blood, and the occurrence of gastric hemorrhage are symptoms sufficiently striking to distinguish it from appendicitis.

PERFORATION OF GASTRO-INTESTINAL ULCERS.

The points to be observed in a differential diagnosis between appendicitis and perforated ulcers of the gastro-intestinal tract—including gastric, duodenal, cecal and colonic, and perforating typhoid ulcer—are the following: The greatest liability to perforation in *gastric ulcer*, according to Barling, is in young women between the ages of seventeen and twenty-five years. There is also a certain liability, though not so great, in males; in adults it occurs chiefly between the ages of forty and fifty. As a rule, a patient with perforated gastric ulcer will have suffered for some time previously from symptoms referable to the stomach. This, however, is not always true, as perforation has occurred in cases in which there has never been a history of indigestion. Perforation of the stomach nearly always occurs in the presence of a full or partly filled stomach, with the patient in the vertical position. Further, a history of exertion in rapidly changing the position of the body, or of coughing or sneezing, may be elicited. The perforation is usually attended by sudden acute pain in the epigastric region, followed by faintness or collapse. The pain is of a burning or scalding character, and is referred to the extreme upper abdomen. Recovery from the depression consequent upon the onset of pain may be followed by bloody vomiting, although this is not universally true. Coincident with the foregoing symptoms there is pronounced rigidity, with a scaphoid abdomen.

Respiration and temperature are both influenced by the condition, the former being hurried and superficial and the latter subnormal. The pulse is rapid and small. The length of time intervening between the occurrence of perforation and a fatal termination will be determined by the size and position of the perforation. The escaped contents of the stomach may be confined between the stomach and diaphragm, the stomach and liver, and the stomach and transverse mesocolon. In such conditions the following peritonitis will be localized and confined to the upper abdomen. These are the more favorable positions for the escape of the stomach contents. In any of these situations a localized abscess may result. When the perforation communicates directly with the general peritoneal cavity, diffuse peritonitis rapidly supervenes. This latter is at first associated with general muscular rigidity, but is soon followed by tympanites and the usual signs of this affection. I submit reports of a few cases:

G. R., a female, aged twenty-five years, was admitted to the German Hospital, January 19, 1897. She had been taken suddenly ill two days previously, having complained prior to that time of dyspepsia and pain in stomach, but had never noticed any bloody vomiting. She was moribund at the time of admission, and died twenty-four hours later with all the signs and symptoms of acute general peritonitis. At the necropsy the stomach presented a perforation about the size of a ten-cent piece at the greater curvature near the pylorus.

A. J., a female, aged twenty-nine years, was admitted to the German Hospital on January 4, 1897. The clinical diagnosis was chronic gastritis and ulcer of stomach; the anatomic diagnosis, ulcer of the stomach, perforative peritonitis with abscess.

It was difficult to get a history, as she could not speak English, but it was elicited that her parents were well; that two brothers and five sisters were healthy; that one sister suffered from the effects of a twin pregnancy; and that two brothers and two sisters died in infancy.

She had lived in Finland until August, 1895, when she came to this country. She worked very hard on a farm while in Finland, and was greatly exposed. She had plain and good food, but no alcoholic stimulants. Her health as a child was good, but has been troubled with dyspepsia for the last fourteen years. She had been in a hospital in Sweden five years ago for similar trouble. Menstruation was established at fourteen years of age. She had had leukorrhea. She complained fourteen years ago of distress in the abdomen after eating. This condition gradually increased in intensity, and was accompanied by frontal headache and flushes, with occasional nausea and vomiting. Attacks would come on at frequent intervals, especially after eating sour articles. She was always constipated. On coming to this country she was in fair health, her weight then being 175 pounds. She worked hard up to time of admission.

On admission her temperature was normal; her complexion was sallow, with pink cheeks; her lips were pale, her pupils were equal and slightly dilated, and her conjunctivæ were pearly. She was fairly well nourished, but has lost fifty pounds, her present weight being 129 pounds. She sweated freely and frequently. There was no glandular enlargement, but there were persistent tenderness over the epigastric region and some vomiting, especially on taking solid food. There was no blood in the vomited matter. Palpitation of heart on exertion was complained of.

On physical examination the chest was well formed; the respiratory murmur was clear; the heart, liver, and spleen were normal. The stomach contents were acid in reaction and contained no free hydrochloric acid.

March 15, 1897.—Blood (about 15 c.c.) was found in the stomach contents.

March 16th.—Blood was again noticed in the stomach contents.

April 5th.—An area of dullness, extending from the ninth to the twelfth rib in the post-axillary line on the left side, and forward to the anterior axillary line, was noted. There was great tenderness over this area. The patient was weak. A diagnosis was made of post-gastric abscess (subdiaphragmatic), which was believed to be the result of slow leakage from a perforated and gastric ulcer.

April 7th.—General peritonitis supervened. Operation was considered unwarrantable. The patient died shortly afterward.

The necropsy report, so far as it referred to the abdomen, was as follows: The abdominal walls are of moderate thickness. The omental apron is present, carrying considerable fat and covering the entire intestinal coils. Coils of small bowel in many places are adherent to each other, and many show areas of deep congestion. The appendix is normal in size, very pale, and slightly indurated at the tip. The colon is pale, but otherwise normal. The pyloric orifice of the stomach is decidedly thickened at a point on the greater curvature two inches above the orifice. There is an adhesion between the anterior surface of the stomach and the gastro-colic omentum, which fold continues adherent throughout the entire greater curvature and is drawn over the anterior surface of the stomach and anchored by adhesions to the diaphragm and the anterior superior border of the left lobe of the liver. This, with the gastro-splenic fold, adherent as it is to the foregoing reflections and the fundus of the organ, forms a new anterior gastric wall, which, when opened, shows ordinary stomach contents, and, at its inferior ventral border, an opening in the stomach wall proper about the size of a quarter-dollar. On each side, three-fourths of an inch distant, is an ulcerated area about the size of a silver dollar, with the mucous membrane perforated, deeply congested, and hypertrophied, presenting conditions simulating malignant involvement. The other organs present no marked abnormalities.

In *perforated duodenal ulcer* the general symptoms are similar to those occasioned by perforated gastric ulcer. The most important point in the differential diagnosis between the two conditions is the appearance, in an individual apparently in perfect health, of a recurrent intestinal hemorrhage followed by anemia. There may be hemorrhage from the stomach coincident with or accompanying a discharge of blood from the bowel. The pain in duodenal ulcer occurs an hour or more after the ingestion of food, while in gastric ulcer it follows immediately. Frequent attacks of hematemesis, associated with neuralgia of the epigastrium and bloody stools, may be considered as pathognomonic of duodenal ulcer.

The question as to the existence of *perforating ulcer of the ascending colon* may arise in the differential diagnosis between appendicitis and the previous conditions. Ulceration of the colon is most likely to be associated with malignant disease, in which event there are present such symptoms as attacks of paroxysmal pain, followed by small bowel movements, containing more or less mucus, which may be mixed with blood; the presence of a mass; the history of slow onset and cachexia. When obstruction exists, the distended coils of intestine may be made out during a paroxysm of pain by examination of the abdominal wall.

Mrs. R., aged sixty years, was admitted to the German Hospital on June 21, 1897. The diagnosis was carcinoma of the cecum; ileo-colostomy.

Her father died of kidney trouble; her mother in childbed. Five brothers and two sisters were alive. She had been married forty years, and had had eight children. Menstruation was regular after marriage. The menopause occurred ten years ago. She had had bladder trouble for some time. A calculus had been removed from her bladder four years ago. In December, 1896, she had the first attack of her trouble. There developed severe lancinating pain in the right iliac fossa, recurring at short intervals; since then she has scarcely passed a day without pain, sometimes having severe exacerbations. She has frequent micturition, without tenesmus, and some ardor urinæ. She states that a small growth was removed from her urethra in May, 1897. There has been no hematuria. She has passed gravel at times, but not lately. There is considerable sacral ache. Her appetite is good and her bowels are regular. Her tongue is pale, but not coated. She has not lost flesh and there is no marked cachexia.

Examination revealed extreme tenderness in the right iliac fossa, and the right rectus muscle was very rigid, simulating a mass. There was tenderness also on deep pressure in the right vaginal vault. The uterus was small and atrophied; there was no discharge. Catheterization revealed no blood, mucus, or stone in the bladder. The urethra had evidently been dilated.

Operation.—An incision was made over the region of the appendix. A coil of ileum was found to be adherent to the cecum. A hard mass being felt about the site of the appendix, the appendix was exposed and found to be completely separated from its cecal attachment. By its removal, with the exudate, a large perforation was found in the ileum, just above its junction with the cecum. The lower end of the cecum was involved in a carcinomatous growth. This was removed by careful dissection, cut away with the cecum, and the bowel closed with continuous silk suture. The terminal four inches of the ileum were next removed, as its mesentery was infiltrated. The ileum was closed with silk sutures and another portion anastomosed with the transverse colon by means of a Murphy's button. Recovery was uneventful.

Acute perforation, the result of intestinal ulceration or rupture of the intestinal wall, in one previously well, may so closely resemble an attack of acute appendicitis that the differential diagnosis may be impossible.

Ordinarily in ulceration of the intestine there is present an area of diffuse pain, confined to that portion of the abdomen overlying the site of the affected bowel. There is also usually a trace of blood or slight intestinal hemorrhage, and pus may be found in the stools. There may be diarrhea and mucous stools. These may all be absent. The cardinal symptoms of appendicitis may be of value in forming a differential diagnosis between intestinal perforation and appendicitis, although in appendicitis the symptoms are usually well marked; this may be also true of intestinal rupture or perforation. The lesion in both instances being similar, produces like symptoms, particularly if occurring in the terminal portion of the ileum, cecum, or ascending colon. The symptoms of intestinal perforation in one previously well are marked: namely, sudden acute abdominal pain, referable to the seat of the lesion, usually accompanied by shock, which in some instances is very profound. There is a leaky condition of the skin and an anxious expression of the face; the pulse is rapid and thready, the temperature subnormal. With reaction, the acute abdominal pain increases, and, if the case be not recognized as an acute intestinal perforation, and cathartics administered, peritonitis of the infective type supervenes more rapidly than it would if the laxatives had not been administered.

Contrast these symptoms with those of early appendicitis—the acute abdominal pain, the tenderness, the rigidity of abdominal walls, nausea, and sometimes vomiting. Ordinarily, these symptoms occur after the ingestion of indigestible food or exposure in some manner. The mere fact that such conditions may closely resemble each other, and that it would be impossible under certain circumstances to arrive at a differential diagnosis except by operation, merely emphasizes the necessity of operation in most cases of acute abdominal disease having the symptoms of pain, rigidity, and tenderness occurring suddenly in one previously well. The following is a case in point which I deem of sufficient value to relate, in order to show the inability to form a differential diagnosis at times between this condition and appendicitis.

M., aged twenty-eight years, a short time after eating a hearty meal was suddenly seized with acute abdominal pain. The pain was referred to the right hypochondrium at about the region occupied by the gall-bladder. The pain radiated from this point to the umbilicus; there was nausea and vomiting. He took some medicine to allay a sick stomach. The same evening a physician was called, who discovered the foregoing state of affairs: There was disturbance of the urinary secretion, the urine being highly colored, scanty, and bile-stained. A diagnosis of acute cholecystitis was made. The patient was given calomel in fractional doses, ice was applied to the abdomen, and milk with whisky in small quantities was given at intervals of three hours. The following morning the area over the gall-bladder was not so sensitive on pressure nor quite so rigid as the night previous. The patient presented an anxious appearance, the skin was bluish and leaky, and there was excessive thirst. On account of slight amelioration of the symptoms in the hypochondriac region and the patient's constitutional depression surgical interference was postponed. The same evening the patient was advised to go to the hospital for operation on account of the symptoms not improving. He did not go, however, until the following morning. Upon consultation the diagnosis was made of acute appendicitis with general peritonitis. The patient's condition was such that operation was deferred until he should react. The usual treatment for appendicitis was instituted. From the first attack or seizure of pain the patient was obstinately constipated, and although castor oil, salts, and calomel had been administered, it was impossible to obtain a bowel movement. An attempt was made at the hospital to secure catharsis, but this likewise failed. The patient died from general peritonitis.

The necropsy revealed the appendix and gall-bladder normal. There was a perforation of the ileum about from 1½ to 2 inches from its junction with the cecum. The abdomen contained feces. The other organs were normal.

CARCINOMA OF THE CECUM.

This should not be confounded with chronic appendicitis. In carcinoma of the cecum there is absence of inflammatory symptoms; palpation reveals the presence of a nodular swelling of slow growth, and attended by progressive loss of flesh; the disease usually occurs late in life; there is absence of marked rigidity of the overlying abdominal wall and of decided tenderness. When the disease has advanced to the extent of offering an obstruction to the fecal circulation, there occur attacks of diarrhea, with mucus and blood in the stools, and paroxysms of acute abdominal pain, the result of the peristaltic action of the bowel. The peristaltic wave can be excited by manipulation of the growth, and can be seen through the thin abdominal wall.

DYSENTERY AND COLITIS.

While dysentery may resemble some of those rarer and unfavorable cases of appendicitis in which diarrhea with bloody stools and tenesmus is added to the three cardinal symptoms, yet differentiation can be established by local examination. In dysentery, though there is diffused abdominal pain, the localized tenderness is over the region of the colon, particularly the sigmoid flexure, and no mass is palpable. Digital examination of the rectum reveals the characteristic tenderness of proctitis.

BILIARY COLIC (CHOLELITHIASIS).

The diagnosis between biliary colic and appendicitis is at times difficult. The onset of both is somewhat similar: namely, acute pain, coming on suddenly, accompanied by persistent vomiting, which is more severe and prolonged in biliary colic. The histories of the two classes of cases will generally show differences sufficiently marked to distinguish them. Less severe attacks of biliary colic will probably have occurred at intervals of several years. These are accompanied by jaundice, which almost invariably becomes pronounced, and which, with characteristic color and pruritus, may persist in a slight degree during the entire interval between the attacks.

Biliary colic is frequently ushered in by a chill. Fever is absent, particularly in the early stages of the disease. The bowels are usually constipated, as in appendicitis; when moved, however, the stools have a dark green color and a peculiar moldy odor. If gall-stones are found, as is frequently the case, the diagnosis is established. The location and degree of pain differ from that of appendicitis, being in biliary colic more continued and severe, and radiating usually from the lower right chest margin to the umbilicus. While in the later stages the pain may become constant, and involve the entire epigastric region, or extend even lower, it will, nevertheless, usually at intervals of two or three days, become localized and more acute in the region of the gall-bladder. In appendicitis the localization of pain is always toward, if not directly in, the right iliac fossa, while between severe paroxysms there is marked tenderness at this point and characteristic rigidity of the overlying abdominal wall.

EMPYEMA OF THE GALL-BLADDER.

A patient the subject of simple empyema of the gall-bladder presents evidences of general constitutional disturbance, though these are usually slight. The temperature may or may not be increased; in some instances the rise in temperature is marked from the onset of the disease, and when associated with chills, is indicative of pus-formation. The pain in empyema of the gall-bladder is ordinarily severe, and will necessitate the recumbent position in order to avoid movements which increase the pain.

The patient, especially if the temperature be high, rapidly grows emaciated and becomes weak, owing largely to the loss of appetite. Jaundice is not always associated with empyema of the gall-bladder, and is present only when there is catarrhal inflammation of the bile-ducts or an impacted stone in the common duct. On account of the localized peritonitis, tenderness is an almost invariable sign. The points to be considered in making a differential diagnosis are the history, the onset, the location and character of the pain, the area and degree of muscular rigidity, and the character and position of the tenderness.

One of the most important points in the differential diagnosis between empyema of the gall-bladder and appendicitis is that, if the patient be seen early in the affection, before adhesive inflammation occurs, the distended gall-bladder will be found to move with respiration and to present itself beneath the margin of the ribs as a fluctuating, rounded swelling.

If the gall-bladder rupture, the pus takes one of several directions. It may escape externally by ulcerating through the abdominal wall directly over the tumor; by following the course of the suspensory ligament of the liver, and evacuating itself through the umbilicus: or, as has not infrequently happened, by rupturing externally in the right iliac region over the cecum or pubes. The contents of an empyema of the gall-bladder may be evacuated spontaneously into the duodenum or transverse colon; the pelvis of the kidney or the ureter; the stomach; or the inferior vena cava, or portal vein.

The differentiation between rupture of an empyema of the gall-bladder, with or without involvement of the ducts, and a ruptured appendicular abscess is extremely difficult, and in most cases the condition will be revealed only by operation. The points to be noted are the previous history and the fact that it is the upper portion of the right rectus muscle that becomes rigid in case of ruptured gall-bladder.

ACUTE PHLEGMONOUS CHOLECYSTITIS AND GANGRENE OF THE GALL-BLADDER.

The differential diagnosis between these affections and acute appendicitis may be extremely difficult, particularly when the former affections are not associated with or due to gall-stones. There may be vomiting in both, although in appendicitis it is not so persistent. In acute phlegmonous cholecystitis or in gangrene of the gall-bladder the symptoms follow in rapid succession. The pain is acute, is located high up on the right side, has a tendency to radiate toward the right scapular region, and later rapidly becomes general. The pulse is quick and of small volume; there is elevation of temperature, though this is not of much diagnostic value; rapid and shallow respiration, thoracic in character; and great depression, amounting almost to shock. The peritonitis, localized at first, soon becomes general, unless adhesions have formed to limit the escaping contents of the gall-bladder. Jaundice is not always present.

In acute phlegmonous inflammation of the gall-bladder a fatal termination most frequently follows shortly after the onset. In the subacute varieties an abscess may be localized around the gall-bladder with adhesive peritonitis, thus simulating an appendicular abscess.

It must be recollected that in appendicitis the point of greatest tenderness is usually located at a spot along the outer border of the right rectus muscle, where it bisects a line drawn from the anterior superior spine of the ilium to the umbilicus. In acute phlegmonous cholecystitis, on the other hand, and in gall-bladder inflammation in general, the point of greatest tenderness is most frequently at the junction of the upper two-thirds with the lower third of a line drawn from the end of the ninth rib to the umbilicus. Early in the disease the differentiation between the two affections calls for the greatest care.

HEPATIC AND PERI-HEPATIC ABSCESS.

Appendicitis can be confounded with abscess of the liver or abscess about the liver only when, late in the disease, a circumscribed collection of pus is in close relation with an appendix which holds a post-colic position and points toward the liver. The previous history, the hectic temperature of hepatic or peri-hepatic abscess, and the absence of a history characteristic of an acute appendicitis will be sufficient to establish the diagnosis of hepatic or peri-hepatic abscess.

RENAL IRRITATION OF APPENDICITIS.

Too much stress can not be laid upon the importance of urinary examinations, not only in all kidney affections, but also in cases of appendicitis.

It is true that in most cases of appendicitis examination of the urine reveals slight abnormalities, such as traces of albumin, cylindroids, hyaline casts, renal and ureteral epithelium, pus, and, rarely, red blood corpuscles. In the affections in which the kidney and its adnexa are involved early the urine will show characteristic peculiarities. The renal manifestations of appendicitis are no doubt toxic; in rare instances they may be, partly at least, the result of actual contact of the appendix with some part of the urinary tract. I have operated upon a patient whose urine contained pus and epithelium from the pelvis of the ureter. There was present a swelling in the right loin, and tenderness, which extended in the direction of the attachment of the appendix; and the history of the three cardinal symptoms of appendicitis was elicited. The right iliac fossa was opened. The appendix, which pointed north, was post-colic and contained pus. It was adherent to, and in communication with, the pelvis of the ureter, through which the contents of the appendix were being emptied into the bladder, thus explaining the urinary symptoms. The recovery was uneventful.

MOVABLE KIDNEY.

Floating kidney is indicated by the presence of an abnormal depression in the right flank, a movable tumor, characteristic in shape, which, by properly directed pressure, can be restored to its normal position. The best position of the patient in which to detect and replace a movable kidney is lying upon the side opposite to that of the organ supposed to be affected. The legs should be flexed upon the thighs, the thighs strongly flexed upon the abdomen, and the vertebra flexed so as to bend the trunk as far forward as possible. The patient is now requested to take one or two deep inspirations, so that if the kidney be movable, displacement of the organ will be assured. In this position the kidney is readily detected and returned to its normal position.

In arriving at a correct diagnosis between movable kidney and appendicitis, first in importance is the fact that movable kidney is most commonly seen in neurasthenic women who have gastro-intestinal disturbances. The attacks of pain in movable kidney are associated with nausea and vomiting, fever, and often chills. In the majority of instances the urinary function is disturbed—as instanced by the frequent desire to urinate, the act of which may be painful—and the urine is large in amount, particularly if the patient be of a nervous disposition. The urine may contain blood, and, as I have seen in some attacks, pus; but the high color of the urine is more likely to be due to the presence of an excess of uric acid or oxalates. The differentiation between the local disturbance during an attack of pain in a movable kidney which is dragging upon its pedicle and appendicitis is, to say the least, highly important. From the history can be learned the frequency of the attacks of pain, the nature of the pain, and the part of the abdomen to which it is referred; whether it is confined to one point or is migratory; whether or not it occurred after the ingestion of a heavy meal, after exposure to cold, or during the period of digestion, or after unusual movement or position or indirect violence. The degree of illness following must be ascertained, as well as the tendency of the patient to constipation or diarrhea. During or following an acute exacerbation of pain due to movable kidney, occurring in either a nervous or a robust individual, local examination will show pronounced rigidity of the overlying abdominal wall, with tenderness, the degree of which is in direct proportion to the muscular rigidity.

The important differential points between appendicitis and movable kidney are these: In appendicitis there is the sudden onset of acute abdominal pain, which most commonly follows the partaking of indigestible foods, and which, at first, is referred to the epigastrium or to the region of the umbilicus, and later becomes localized in the right iliac fossa. The presence of fever and an increased pulse-rate are more indicative of appendicitis. In appendicitis, also, the rigidity of the lower portion of the right rectus muscle, and of the flat muscles of the abdominal wall immediately overlying the inflamed appendix, differs from the rigidity present in movable kidney, in that it does not involve so great an area. The most acute tender point, which corresponds to the position of the inflamed appendix, is, at least early in the inflammation, more circumscribed than the tenderness in movable kidney. The tender area over a movable kidney is not so painful to slight pressure and extends over a greater region. The pain, which, as a rule, is not so intense, is at once referred to the site of the kidney or is reflected along the course of the ureter. Movable kidney attended by both pain and rigidity requires very delicate manipulation in order to detect it. By having the patient breathe with the mouth open, and with the thighs slightly flexed upon the abdomen, gentle pressure enables us to detect the kidney slipping away from the examining finger. There are cases, however, in which nothing short of anesthesia will clear up the question of a movable kidney. The presence of nausea, extending over days, is one of the most prominent symptoms in certain cases of movable kidney.

The operator may be thrown off his guard by acute indigestion occurring in a nervous individual suffering at the same time from acute paroxysms of pain due to a movable kidney, which was previously not known to the patient or to the physician. Under these circumstances the kidney may become temporarily anchored in its abnormal position. Under the foregoing conditions I have been called upon to operate for acute appendicitis, but could not say definitely that the case was not acute appendicitis until the patient was fully anesthetized; then, upon palpation, the diagnosis at once became clear.

Again, in the presence of both conditions,—*i. e.*, movable kidney with acute symptoms and an enlarged appendix due to chronic inflammation,—examination under ether will disclose not only the abnormal condition of the kidney, but also the presence of a palpably enlarged appendix. If, under these circumstances, the patient has been suitably prepared, an appendicular operation should be performed. The operator whose experience in appendicular work has been rich can usually say, upon what to the bystander seems to be a superficial examination of the abdominal wall, whether the case be one of movable kidney or appendicitis. On the same principle, in the presence of a peritonitis the result of appendicitis the everyday operator can often separate the operative from the nonoperative cases merely by palpation of the abdominal wall.

FLOATING KIDNEY WITH A TWISTED URETER.

Floating kidney with a twisted pedicle may cause abdominal pain, nausea, vomiting, and chills and fever, which symptoms may suggest appendicitis. This condition may be diagnosticated from appendicitis by pain which radiates in the line of the ureter and is not increased to any marked degree by pressure; a history of a movable tumor prior to the attack; a depression in the right loin corresponding to the site of the kidney; the presence of blood in the urine; possibly symptoms of uremia; and absence of the cardinal symptoms of appendicitis.

NEPHRITIC COLIC.

Ordinarily, it should not be difficult to differentiate between nephritic colic and appendicitis, but misleading conclusions may be reached, owing to the fact that in exceptional cases of appendicitis there exist together pain referred to the umbilicus, retraction of the testicle associated with vesical tenesmus, and painful and frequent micturition. Error, however, can occur only in the early stages of appendicitis, as later the symptoms of the two conditions are entirely dissimilar.

Renal colic is usually ushered in by a distinct chill, followed by excruciating pain in the loin posteriorly, which is usually increased by pressure. The pain extends along the course of the ureter, and is much diminished by the voiding of urine, which often amounts to large quantities. In appendicitis the pain at the onset is more diffused, is increased by pressure, and is in no way affected by micturition. In renal colic there is no rigidity of the abdominal wall, no tender mass in the right iliac fossa can be palpated, and examination of the urine shows characteristic alterations: *e. g.*, uric acid or phosphatic deposits, blood, etc. The use of the X-ray in the diagnosis of stone in the kidney is satisfactory in most, if not all, cases.

I recall the case of a physician in whom the diagnosis of renal colic had been made, and in whom the ureter was supposed to have been ruptured by the passage of a calculus. The autopsy revealed a gangrenous and perforated appendix with diffuse suppurative peritonitis.

PYO-NEPHROSIS.

From abscess of the kidney appendicitis differs in that in the former the onset is gradual, and may be preceded by disease of the bladder; the pain radiates from the kidney or ureter to the umbilical region, groin, and testicle, and retraction of the latter occurs. In appendicitis the onset is sudden, and the pain begins in the peri-umbilical region and soon localizes itself in the appendix. Tenderness in abscess of the kidney is the most reliable symptom, and is elicited by pressure over the renal region; and in appendicitis it is detected over the appendix, the tip of which seldom reaches the level of the kidney even when it is directed upward. In pyo-nephrosis there is irritability of the bladder and diminished excretion of urine, which contains pus and [illegible] blood. In the absence of [illegible] abscess of the kidney, and particularly [illegible] greater difficulty [illegible] however, the tumor [illegible] in a case of acute [illegible] the tumor was [illegible] anatomic situation of the swelling, in the absence of the characteristic symptoms of appendicular inflammation. Nausea, sometimes associated with vomiting, is a fairly constant symptom in the renal cases, though it is not of positive diagnostic value.

PERI-NEPHRITIC ABSCESS.

When the appendix holds a retro-colic position or occupies a deep ileo-cecal fossa, and inflammation of that organ has progressed to the formation of pus, the collection may be mistaken for a peri-nephritic abscess. The presence of intestinal disturbance and of the cardinal symptoms of appendicitis, however, will be sufficient to justify a diagnosis of appendicitis. When the appendicular abscess is in relation with the right kidney, an incision through the loin, such as is made for the evacuation of a peri-nephritic collection, may be followed by the discharge of purulent matter. It must be borne in mind, however, that the evacuation of a supposed peri-nephritic abscess in this manner does not disprove that the collection of pus was not in reality of appendicular origin. A case in point is the following:

The original diagnosis was appendicitis, and, on account of the desperate condition of the patient, an incision for the evacuation of the collection was made through the loin. Recovery with repair of the wound followed. The patient, however, was unable to resume his occupation on account of localized pain, referred to and above the posterior half of the crest of the ilium. Six weeks after recovery from the operation for the evacuation of the abscess he was again referred to me. Upon examination the incision was found intact, but tender. Upon palpation of the painful point distinct resistance was noted. Removal of the appendix was recommended. When the patient was under the anesthetic, and was being placed upon the operating table, a distinct fecal odor, which was thought to be due to a bowel movement, was noticed. Upon the removal of the antiseptic dressing which covered the proposed field of operation it was found that the cicatrix had broken down at one point and that fecal matter was escaping from it. Believing this to be a fecal fistula, the result of an original attack of appendicitis, I opened the abdomen, isolated the field of operation by gauze packing, and located the appendix. The tip of the organ was perforated and its lumen was found to be in direct communication with the fecal fistula. The appendix was removed and the wound was disposed of after the manner of such cases. I have treated other cases of like character.

TUMORS OF THE KIDNEY.

Neoplasms of the kidney are recognized by palpation of the loin space, absence of inflammatory symptoms, continuous dull pain, frequent micturition, hematuria, and pyuria. Cystoscopic examination of the bladder, with catheterization of the ureters, may be necessary. The cardinal symptoms of appendicitis are absent.

URETERITIS.

Inflammation of the ureter occurs as a sequel to inflammation of the bladder, or in connection with tuberculous and calculous disease of the kidney. The differential points are: The history; the presence of tenderness at the bladder extremity of the ureter, as made out by vaginal or rectal examination; the presence of deep-seated tenderness along the line of the ureter; the absence of rigidity of the abdominal wall; and the presence in the urine of pus, blood, and ureteral epithelium. Introduction of a bougie into the affected ureter with the aid of a cystoscope assists in making the diagnosis.

PAINFUL MENSTRUATION.

A condition which may be misleading in the differentiation from appendicitis is the sudden onset of pain occurring in young unmarried women of neurotic temperament at the beginning of the menstrual period. The onset is sudden and the pain is paroxysmal and accompanied by nausea. There may be more or less unilateral or bilateral rigidity of the lower abdominal wall. The presence of rigidity of the abdominal wall and its degree depend upon the amount of congestion of the ovaries, whether one or both be involved. The pain, at first paroxysmal, is most severe during the first day of the menstrual flow. After this it may become continuous, and, in some instances, may last during the entire period. The tenderness, like the rigidity, corresponds to the amount of the ovarian congestion. If both ovaries are involved, the tenderness will be bilateral.

The pain at the onset differs, however, from that of appendicitis, being noninflammatory and localized from the beginning, while in appendicitis there is general abdominal pain, which later becomes localized in the right iliac fossa, while marked intestinal symptoms are present. Vaginal and rectal examination will assist very materially in arriving at a correct conclusion.

MENOPAUSE.

Some women during the climacteric occasionally complain of symptoms which resemble appendicitis. They suffer from localized pain in the right side, gastric and intestinal disturbances, and irregular temperature. As absence of the menstrual flow often exists, some difficulty may be experienced in reaching a correct diagnosis, particularly in those cases associated with obesity. The exact condition, however, may be established by inquiry into the previous history and by local examination, which latter demonstrates absence of rigidity of the abdominal wall and no tenderness or palpable swelling about the appendix. The flushes, backaches, and mental symptoms incident to the menopause will clear up the diagnosis. In this connection hysteria may be referred to, particularly as appendicitis has become a more or less "fashionable" disease. The mere mention, however, of the nervous affection, with its ubiquitous symptoms, will suffice.

VARICOSITY OF THE VEINS OF THE BROAD LIGAMENT.

A varicose condition of the veins of the broad ligament may simulate chronic appendicitis. A differential diagnosis should be easy to make, however, because there is an absence of inflammatory symptoms, and a characteristic dull aching pain, with nausea, which disappears when the veins are emptied, after the patient has assumed the recumbent position. Again, in chronic appendicitis there is a history of one or more acute attacks, a palpably enlarged organ can be detected, and the symptoms of chronic appendicitis are present.

UTERINE FIBROIDS.

Appendicitis may be confounded with a local inflammation of a portion of the broad ligament overlying an intraligamentary fibroid tumor. The main points in the differential diagnosis are that in the latter there are a history of metrorrhagia; the presence of a growth can be detected upon vaginal examination, and in some instances through the abdominal wall; tenderness and pain are elicited by bimanual palpation, and are confined to the part of the abdominal wall overlying the mass; and the history of appendicitis is absent.

EXTRA-UTERINE PREGNANCY.

The history of cases of extra-uterine pregnancy is usually that of partial or complete cessation of the menstrual flow for one, two, or more periods, generally accompanied by other symptoms of pregnancy, and collapse supervening upon an attack of acute abdominal pain. The pain is long-continued and paroxysmal, but not of the nature of intestinal colic. An irregular, bloody, vaginal discharge, generally lighter in color than the normal menstrual flow, and containing shreds of tissue,—portions of the decidua,—is present. Vaginal examination reveals a tender and sensitive mass in Douglas' culde-sac, unless the pregnancy be an abdominal one. In the majority of these cases there is a history of sterility for five or six years previous to the abnormal conception.

When the product of conception occupies the fimbriated extremity of the right tube, the points of differentiation are more difficult, owing to the close proximity of the lesion to the appendix, and to the negative result of examination *per vaginam* prior to rupture. Should the two conditions occur coincidentally, it will be well-nigh impossible to differentiate between them. The chief points to be borne in mind, however, are the history, the absence of inflammatory symptoms prior to the rupture of the extra-uterine sac, and the presence of inflammatory symptoms in appendicitis.

ACUTE SALPINGITIS.

There frequently is a close relationship between acute appendicitis and right-sided acute salpingitis, and the symptoms of each affection may closely resemble those of the other. The principal points of differentiation, however, in acute salpingitis are the history of specific infection, the slight degree of abdominal tenderness and rigidity, the location of the pain, and the absence of vomiting; and, in case of appendicitis, the pain migrating from the epigastric or peri-umbilical region to the right iliac fossa, the decided rigidity of the lower right quadrant of the abdominal wall, the tenderness in the right iliac fossa, the detection by pressure of a palpably enlarged appendix, the suddenness of the attack accompanied by vomiting, no history of infection, and the absence of signs of salpingitis by vaginal examination. In inflammatory affections of the uterine appendages the most tender external point is just above the middle of Poupart's ligament, while in appendicitis it is in the right iliac fossa.

PYO-SALPINX AND OVARIAN ABSCESS.

The presence in the recto-uterine culdesac, in intimate relation with the uterus, of an inflammatory mass which renders the uterus partly or completely immovable, and which can be clearly outlined by vaginal, bimanual, or combined vaginal and rectal examination, together with the history of a vagino-uterine infection and the presence of a septic fever, establishes the diagnosis of pyo salpinx or of tubo-ovarian or ovarian abscess. Still, an inflamed appendix directed into the pelvis, and lying in relation with the right tube and ovary, will simulate pyo-salpinx or a tubo-ovarian or an ovarian abscess of the right side in that there will be an inflammatory mass near the uterus and pain and tenderness upon vaginal or rectal examination, or both. The diagnosis of appendicitis is established by the history of previous attacks, a sudden onset of abdominal pain, usually becoming localized in the right iliac fossa, and rigidity of the abdominal wall. Tenderness in the right iliac fossa is present in both diseases, but in appendicitis the tender area occupies the higher position.

Inflammation of the right ovary may be confounded with appendicitis, as it is attended with pain, tenderness in the right iliac fossa, nausea, and fever. It is, however, always accompanied by disturbances of the uterine functions, and is demonstrable by vaginal or bimanual examination. The pain in appendicitis is at first in the peri-umbilical or epigastric region, and becomes localized in the right iliac fossa. The tender area in appendicitis is situated in the iliac fossa, further to the right than in inflammation of the ovary, and the tenderness is never so intense as in appendicitis and is not accompanied by a perceptibly enlarged appendix.

SUPPURATING OVARIAN CYST.

An appendicular abscess and a suppurating ovarian cyst on the right side present in common some symptoms which may give rise to difficulties in diagnosis. There are painful tumor in the right iliac fossa, which may be made out by vaginal, bimanual, and external examinations; vague symptoms of septicemia; hectic temperature; and a history of previous gastric and urinary irritation. The differences, however, are marked by careful consideration. In ovarian cyst the onset is gradual and a history of some infection can generally be elicited. The pain is constant and dull in character; by pressure the significant " ovarian pain," which differs from the colicky appendicular paroxysms, may be produced. The rigidity of the abdominal wall is not so marked as in appendicitis, while the tumor itself is more elastic, and apparently has thinner walls and a more regular outline. If the abscess be of appendicular origin, there will usually be a history of one or more attacks which presented the characteristic symptoms of appendicitis.

OVARIAN CYST WITH TWISTED PEDICLE.

An ovarian cyst with a twisted pedicle gives, as a rule, a history of a slowly growing tumor, which is so frequently unaccompanied by pain that its presence is often unsuspected until the accident occurs. The onset of the acute symptoms of a cyst with a twisted pedicle is sudden, and is usually caused by excessive peristalsis of the intestine or by sudden change of the position of the body, causing the tumor to rotate on its pedicle. If the twisting be complete enough to shut off the circulation, the walls of the cyst rapidly become gangrenous and the patient's condition grows profoundly septic, while the localized peritonitis soon becomes generalized. Here, again, is seen a resemblance to an attack of appendicitis with abscess formation; but the difference in the shape and the elasticity of the swelling, the slow growth preceding the sudden onset, the difference in the character of the pain and tenderness, and the more general rigidity of the abdominal wall should enable one to distinguish between the two. If, however, for any reason it be impossible to make a differential diagnosis, I would advise that at operation the lateral incision be the one chosen, because appendicitis is so much more common an affection that the chances are in favor of its being the cause of the symptoms. If, however, an ovarian cyst be disclosed, the lateral opening may be closed and a median incision made for its removal. The median incision for appendicitis is illogical, unwise, and in many instances will present anatomic impossibilities. When the appendix lies behind the cecum and observes one of the northerly directions, especially if adherent, it will present difficulties in its removal even through the ordinary incision. It is, therefore, plainly to be seen how much more difficult would be its attempted removal through a median opening. These difficulties are generally increased when there is pus formation, and, further, the dangers of peritoneal infection are generally multiplied by any opening other than the lateral.

SPLENIC ABSCESS.

This rare affection may sometimes be confounded with those exceptional cases of appendicitis in which pain is referred to the left hypochondriac region. In both there are gastric disturbances, pain, tenderness on pressure, rigidity over the affected area, and similar irregularities in temperature. The previous histories of the two diseases are, however, unlike. Traumatism usually plays a prominent part in the causation of splenic abscess, this being rarely the case in appendicitis. Then, too, splenic abscess occurs in general septic infections and in those constitutional diseases in which enlargement of this organ takes place, and is due to embolism in the parenchyma of the spleen. In neglected cases of appendicitis splenic abscess is a grave complication, and the symptoms referable to the spleen may then predominate.

DISEASE OF THE PANCREAS.

The affections of the pancreas that are most likely to be mistaken for acute appendicitis are hemorrhage into the pancreas, acute hemorrhagic pancreatitis, suppurative pancreatitis, and gangrene of the pancreas. It is hardly necessary in this connection to narrate the factors of importance in the differential diagnosis of these various conditions, which are comparatively rare, and which often follow one another in the same person. Suffice it to mention that any of these disorders of the pancreas, rather than appendicitis, is suggested by the patient being an obese, alcoholic individual of middle life; by a history of previous attacks of severe pain in the region of the pancreas, attended by vomiting, collapse, and fever; by tenderness and rigidity of the abdominal muscles of the epigastric region; by the presence, in the region of the pancreas, of a deep-seated tumor, which does not move with respiration, and which may reveal an indistinct sense of fluctuation; by the possible occurrence of jaundice, fatty diarrhea, and glycosuria; by the absence of the cardinal symptoms of appendicitis; and by the rapidly fatal course of the disease in many cases.

TUBERCULOUS PERITONITIS.

The early stages of tuberculous peritonitis, especially in those cases in which the affection of the appendix perhaps antedates that of the peritoneum, offer great difficulty in diagnosis. The cardinal symptoms of appendicitis may be present, in which case the endeavor must be to diagnose the tuberculous nature of the affection. Careful examination of the patient for evidence of infection elsewhere—*e. g.*, of the family history, sputum, chest, glands, bones, joints, etc.—may lead to the recognition of the tuberculous character of the lesions.

The typical irregular or hectic temperature and night sweats are of value in the diagnosis of tuberculous disease. The most significant symptom, however, is the presence of ascites, which in tuberculous peritonitis appears early. Though often considerable in quantity, its recognition is sometimes obscured by intestinal distention. The pain and tenderness usually tend to diminish with increase of abdominal tumescence. The case of H. W. (Plate XVIII) is a typical illustration of the disease, which possibly originated in the appendix.

CIRCUMSCRIBED PERITONITIS DUE TO INFLAMMATION OF RIGHT SPERMATIC CORD.

Differentiation between appendicitis with circumscribed peritonitis and circumscribed peritonitis of the lower right quadrant of the abdomen due to extension of inflammation of the right spermatic duct can be made by observing the following points: Inflammation of the right spermatic duct follows urethritis, prostatitis, or epididymitis. Consequently there is, or there recently has been, discharge from the urethra, and there is tenderness of the prostate, tenderness and enlargement of the epididymis, and tenderness and swelling of the spermatic cord. The history and the three cardinal symptoms of appendicitis are absent. In the circumscribed peritonitis associated with inflammation of the spermatic duct the most tender point corresponds to the position of the internal abdominal ring, while in appendicitis it is most commonly at McBurney's point. In a terminal appendicitis when the appendix is directed downward and curved, the most tender point may, however, be immediately above the middle of Poupart's ligament. I have seen cases in which the two conditions have been confounded.

PSOAS ABSCESS.

The difficulty attending the diagnosis between chronic appendicitis and incipient psoas abscess—that is, before the pus has passed any distance down the psoas sheath—has been forcibly brought to my mind. The chief points in favor of a forming psoas abscess are the appearance of the patient, usually suggestive of tuberculosis; the information to be obtained by an examination of the spine; a complete temperature record; and a tendency to flexure of the thigh of the affected side. While the flexure of the thigh may be and is present in some cases of chronic appendicitis, it is, nevertheless, a far more frequent accompaniment of psoas abscess. Palpation will, in the great majority of cases of chronic appendicitis, determine the presence of an enlarged appendix, while deep pressure over the right iliac fossa will, in cases of psoas abscess, reveal tenderness of the psoas muscle, but fail to disclose either the presence of an enlarged appendix or the characteristic rigidity of the flat muscles of the abdominal wall.

LUMBAR ABSCESS.

In this affection the history of spinal disease, the position of the swelling, the edema of the overlying tissues, the slow onset, and the absence of acute tenderness, rigidity, and abdominal symptoms will suffice to make the differential diagnosis from appendicitis.

ABSCESS OF THE ABDOMINAL WALL.

Between abscess of the abdominal wall and appendicular abscess there should be but little difficulty in arriving at a correct differentiation. If the collection be in the superficial fascia, it will be circumscribed; but if between the abdominal muscles, it is likely to be diffused. The purely local character of the abdominal abscess, the swelling moving with the abdominal wall, the absence of intestinal symptoms, the presence of local and constitutional evidence of pus, coupled with the history of the case, should be enough to render a differential diagnosis possible.

ANEURYSM OF THE ILIAC ARTERY.

A circumscribed collection of pus in relation with the iliac artery, and occurring in acute or chronic appendicitis, may be confounded with aneurysm of that vessel. Though the pus formation may have transmitted pulsation, this is not expansile nor accompanied by a murmur.

ENLARGED MESENTERIC GLAND.

An enlarged mesenteric gland may be mistaken for the appendix when palpating the abdomen in cases of supposed appendicitis. Their presence, however, is not significant unless accompanied by the evidence of acute inflammation.

MESENTERIC HEMATOCELE.

As a result of traumatism rupture of the mesenteric blood vessels sometimes occurs, and is followed by the formation of a mesenteric hematocele. Under ordinary circumstances absorption takes place. When the hematocele undergoes suppuration, symptoms which closely resemble chronic appendicitis may be observed. By bearing in mind the history, the character of the onset, and the absence of the cardinal symptoms of appendicitis a diagnosis is readily made.

LEAD-POISONING.

The symptoms of appendicitis and lead-poisoning are to a certain extent similar, yet a differential diagnosis should not be difficult to arrive at.

In appendicitis there are present the cardinal symptoms—pain, tenderness, and rigidity. The pain in appendicitis, like that in lead colic, is at first paroxysmal, but, unlike the pain in lead colic, is not relieved by pressure. The tenderness in appendicitis is usually confined to the affected area, unless peritonitis be present, while the tenderness in lead colic is referred to the entire abdomen. The rigidity is localized, as a rule, in appendicitis, and bears a relation to the position held by the appendix. The rigidity in lead-poisoning is diffused. The bowels are usually constipated in appendicitis, although diarrhea may be present. Upon thorough catharsis the symptoms of appendicitis may to a certain extent abate. In lead-poisoning obstinate constipation is the rule, and movement of the bowels is seldom followed by cessation of the pain or colic.

In lead-poisoning the constitutional evidences of the affection are in evidence,—viz., the blue line on the gums, the anemia, and the palsies, either localized or general,—while in appendicitis the constitutional evidences of the disease are those secondary to an acute inflammatory affection.

INCIPIENT INGUINAL HERNIA.

The discomfort attendant upon a chronic appendicitis must not be confounded with that of an incipient inguinal hernia. I have frequently seen cases of marked intestinal indigestion, in the absence of a palpably diseased appendix, and accompanied by more or less discomfort, if not pain, in the lower abdomen, described in some instances as being dragging in character. In these, a careful examination of the inguinal canal showed weakness of the abdominal wall at the site of the internal ring, and the wearing of a light truss was soon followed by the disappearance of all symptoms.

HIP-JOINT DISEASE.

The presence of the characteristic deformity; inability to execute the normal movements of the joint; pain, referred to the knee; arching of the lumbar spine when the thigh is brought into the fully extended position; and the absence of abdominal symptoms, should determine the diagnosis of coxalgia. The absence of the cardinal symptoms of appendicitis and the difference in the mode of onset will exclude appendicitis in suspected cases.

DISLOCATION OF THE HIP.

That acute appendicitis can be mistaken for dislocation of the hip can hardly be conceivable, yet this error has occurred, and is illustrated by the following case:

A very muscular, adult male, a negro, while riding a bicycle fell, striking his right hip. During the night after the accident he suffered pain in the region of the injury, which disabled him. The next day he ate heartily of ice-cream. Acute abdominal pain soon followed. A neighboring doctor being sent for, he found the patient occupying the dorsal decubitus, and the right thigh strongly flexed and adducted, and made a diagnosis of dislocation of the hip. Morphin was given freely. Three days later the patient was admitted to the German Hospital. The following condition was noticed: The abdomen was generally distended, tender, and rigid. The rigidity and tenderness, however, were more pronounced immediately above the crest of the right ilium, just behind the anterior superior spine. In this location the tenderness was most excruciating upon slight pressure. The thigh was in the position previously noted, and any attempt to manipulate it excited unbearable pain. The bowels had not been moved since the accident. The pulse was 88, the temperature 99⅖° F. Careful examination of the hip convinced me that the accident bore no relation to the case. A diagnosis of acute appendicitis with retro-cecal abscess was made. Immediate operation exposed a gangrenous terminal appendicitis, with the appendix holding a retro-cecal position, lying upon the psoas muscle and surrounded by a small collection of offensive pus.

PNEUMONIA AND PLEURITIS.

The onset in these two diseases is sometimes very acute and the pain in the side is so severe as to cause rigidity of the abdominal muscles. If the right side be affected, the diagnosis is sometimes quite difficult, especially in children, who are unable exactly to describe their pain. Careful physical examination will, however, clear up the diagnosis.

HYSTERIA.

Under certain circumstances, such may be the manifestations of hysteria that appendicitis may be suspected. Examination in these cases, however, will usually reveal the patient to be neuropathic. On palpation of the abdomen there may be detected exquisite skin hyperesthesia and immediate rigidity of the abdominal muscles. Upon the patient's attention being diverted, however, deep palpation may be made without eliciting pain or tenderness, and no enlargement of the appendix will be determinable. In addition, it will be ascertained upon inquiry that the so-called acute attacks are unaccompanied by vomiting or fever, and that in the supposed chronic cases there is no disturbance of the gastro-intestinal tract. Further examination will reveal the knee-jerks and other reflexes exaggerated, diminution of the visual fields, and various areas of anesthesia of hysteric type. The condition may be improved or cured by local electric treatment.

It must, however, be borne in mind that appendicitis and hysteria may be concomitant conditions, and that chronic appendicitis may give rise to aggravated neurasthenia.

PTOMAIN-POISONING OR FOOD INFECTION.

The symptoms the result of ptomain-poisoning or food infection often much resemble those of appendicitis, and give rise to many perplexities in the effort to discriminate between them. In both the onset is similar; that is, there develop suddenly acute abdominal pain, nausea, and vomiting. In appendicitis inquiry, however, will elicit a history of the ingestion of indigestible food, whereas in ptomain-poisoning it may be ascertained that the patient has partaken of foods known to be capable of causing food infection. Of these, may be mentioned canned meats, sausages, oysters, especially during the summer months, ham, cheese, ice-cream, cream-puffs, etc. In ptomain-poisoning there is usually a period of incubation after the ingestion of the deleterious food, that varies usually from twelve to thirty-six or forty-eight hours. During this time the patient may be seemingly well or there may be fleeting pains in the abdomen and more or less malaise. In appendicitis, on the contrary, the first manifestations come on suddenly. The pain in ptomain-poisoning is usually violent, referred to the region of the stomach, and associated with nausea, vomiting, diarrhea, and great constitutional depression, as indicated by clammy skin, subnormal temperature, a facial expression of anxiety, and a marked sense of prostration. The pain is unlike that of appendicitis, in that it is continuous, not paroxysmal; and in that it is referred to the epigastrium, and then becomes diffuse and not localized in the right iliac fossa. Rigidity of the abdominal muscles and tenderness on pressure are also diffuse and do not become localized in the right iliac fossa. Vomiting is usually present, though it may be absent; and when present, usually affords temporary relief, and the same is also true of diarrhea. In some cases diarrhea is more likely to occur than vomiting, and it may be entirely unrestrainable. In other cases, particularly of tyrotoxicon poisoning, the vomiting is more likely to be the obtrusive symptom. The evidences of collapse coming on almost immediately after the onset of the first manifestations are most significant of ptomain-poisoning. Indeed, the rapid occurrence of such collapse, with diffuse abdominal pain, tenderness, rigidity, and distention; nausea, vomiting, and diarrhea; and the history of the ingestion of unwholesome food or of food that may be looked upon as possibly unwholesome, are quite characteristic of the condition. In appendicitis, on the contrary, there is a regular sequence of events—abdominal pain, tenderness, and rigidity, with nausea and vomiting usually ceasing after the localization of the symptoms in the right iliac fossa. The profound collapse is never seen in appendicitis so early in the attack as it is in ptomain-poisoning, but, as already mentioned elsewhere, may develop later. In ptomain-poisoning the temperature is usually subnormal early in the attack, and may remain so, but sometimes it rises to 103° or 104° F.; in appendicitis it usually rises with the commencement of the attack. In ptomain-poisoning with a low temperature the pulse may be rapid. The distention of the abdomen is due to paralysis of the intestine, and may be so marked that absolute constipation may occur, and the case much resemble intestinal obstruction, for which it has been mistaken. In addition, there are usually present pains in various portions of the body, irregular muscular twitchings, cramps in the calves of the legs, excessive perspiration, somnolence, and delirium. Finally, the condition sometimes does not yield to any treatment, and the patient speedily dies. At operation, if such be undertaken with the idea that the case is one of appendicitis or intestinal obstruction, the appendix is found normal, but the intestines are usually the seat of irregular distention and more or less congestion.

PROGNOSIS.

The prognosis in a given case of appendicitis has reference, first, to the attack from which the patient may be at the moment suffering, and, secondly, to the future health of the patient. There can be no question that under all circumstances appendicitis is a most serious disease. It resembles certain other diseases,—typhoid fever, for instance,—in that at the time of examination of the patient the local and general conditions may be such that the unwary would give a favorable prognosis, whereas the judicious and conservative physician or surgeon, from his knowledge of the morbid processes at work, states that the present condition of the patient is favorable, but at the same time frankly acknowledges his inability to foretell what may occur within the coming hour. An attack of typhoid fever may be pursuing a favorable course until, entirely unannounced, intestinal hemorrhage or perforation occurs and completely alters the aspect of the case. Similarly, a patient suffering with appendicitis may be progressing favorably, when suddenly gangrene or perforation of the appendix or rupture of a circumscribed peri-appendicular abscess may develop, and his condition may become most serious.

With reference to the attack of appendicitis from which the patient may be at the moment suffering, it is doubtless true of appendicitis, as of other diseases, that a certain proportion will subside under any treatment dictated by reason and the requirements of hygiene. It is sometimes asserted that from eighty to ninety-five per cent. of all cases will recover under medicinal, as opposed to surgical, treatment. But this is contrary to both my experience and my *a priori* judgment. Too frequently I have seen patients who were apparently recovering, or who were accounted as having entirely recovered, suddenly lapse into a critical condition, and sometimes die, despite the most heroic measures to prolong their lives. The reasons for the nonrestoration to health of the appendix in such a large proportion of cases as has been claimed by some must be evident to all who have the slightest acquaintance with the pathology of appendicitis. The likelihood of the subsidence of the inflammatory phenomena in an appendix and of the return of the organ to a healthy condition decreases with the increase in the number and severity of the attacks. The reasons for this will be evident to those who read the chapter on the pathology of the affection.

Specifically, the prognosis in many of the cases that are characterized clinically as mild, in which there is no demonstrable tumor, but little tenderness, and slight fever, and in which the lesions are probably catarrhal or a minor grade of interstitial alterations, is good with reference to recovery from the attack, but poor with reference to the subsequent health of the patient. The prognosis with reference to recovery from the attacks is good only with the reservations that it becomes progressively worse with each succeeding attack, and that we are unable to state at what moment the pathologic alterations may become much aggravated and perforation or gangrene of the appendix ensue. Then it must also be borne in mind that relatively mild clinical manifestations may be associated with serious anatomic lesions, and that we are not warranted in assuming the absence of the latter from the presence of the former. The prognosis as to recovery from the attack is good, particularly in those of this class of cases in which a rapid amelioration of the symptoms follows the administration of purgatives. These cases often terminate favorably without recourse to operative measures, but the appendix remains in a diseased condition, and is liable at any time to most acute exacerbations of inflammation, with their attendant dangers.

Those cases that present a demonstrable tumor, marked tenderness, and rigidity of the abdominal muscles are always most grave, and with reference to them, the careful physician or surgeon is always most cautious in his prognosis. In most of these cases we are warranted in assuming the presence of pus, but we are unable to state whether the appendix is perforated or gangrenous, whether rupture of a peri-appendicular abscess into the general peritoneal cavity or into the intestine or other intra-abdominal organ is imminent, or whether erosion and necrosis of one of the iliac vessels is developing, etc. Such is the serious import of these conditions, concerning which we can state nothing definitely, that the prognosis, under such circumstances, is at most a mere hazard.

Such being the condition of affairs, the prognosis in a given case of appendicitis depends more upon the form of treatment instituted at the onset than upon any other factor. If the appendix be skilfully removed within twenty-four hours from the commencement of the attack, the prognosis is favorable, and recovery will ensue in all but the most exceptional cases. Reference has previously been made to the fact that the adoption of the laxative treatment will be followed by recovery in a certain proportion of mild cases. If, however, the opium treatment be prescribed, an unfavorable termination of the case is more likely, both because an apparent amelioration of the symptoms is thus produced, and because certain serious conditions and complications are likely to develop unannounced by clinical manifestations. The prognosis is the better if the laxative treatment be adopted at the commencement of the attack, because this treatment increases intestinal peristalsis and favors the expulsion of the noxious contents of the appendix. The opium treatment, on the other hand, results in the inhibition of peristalsis and the retention in the appendix of its contents. The administration of opium also lends to the physician a false sense of security. Such is the amelioration of the symptoms that follows its use that he is often led to infer that the progress of the disease has been checked or that recovery has resulted. In many of these cases, however, despite the abeyance of the symptoms, the disease is steadily progressing, and the physician's attention is finally attracted to the serious condition of the partly narcotized patient by the distended and tympanitic abdomen, the "leaky skin," and the rapid, irregular, and weak pulse.

The prognosis is materially influenced by the conditions as found at operation. If the appendix be but slightly altered, and there be but a small amount of serous or sero-fibrinous exudate about the appendix, the outlook is most favorable. Patients with such conditions should not die. If there be a circumscribed peri-appendicular abscess, shut off from the general peritoneal cavity by a firm fibrinous exudate, it matters not whether the appendix be perforated or gangrenous, the prognosis, with certain reservations, is good. These reservations have reference to the kind of treatment adopted prior to the operation, the condition of the patient at the time of operation, the care practised in the administration of the anesthetic, the skill exercised in the operative manipulations, the thorough removal of all purulent foci, the preservation of the general peritoneal cavity from infection, the presence of other diseases (as tuberculosis, heart disease, nephritis, etc.) in the patient, thorough drainage, and the after-treatment adopted. If there be a general peritonitis, of whatever variety, the outlook is ominous. Such are the conditions sometimes found that it may be stated with positiveness that the patient will certainly succumb. In some cases the inflammatory process is of such a fulminating character that it may be impossible to secure the services of a surgeon sufficiently early to prevent a fatal termination. In some cases the fatal termination is inevitable from the outset, but the chances of recovery in all are materially enhanced by immediate operation.

Presuming that a patient recovers from an attack of acute appendicitis, the prognosis with regard to his subsequent health varies with a number of circumstances. A few patients have a mild or even a moderately severe attack, recover, and never have any further symptoms. In general, the milder the primary attack, the more the likelihood of such being the case; but this is by no means an invariable rule. In the majority of cases recurrences sooner or later develop. Most of these occur within the first six months after the first attack; there are fewer within the succeeding six months; and the likelihood of recurrence decreases with succeeding years. The second attack, however, may occur after the lapse of a number of years. Multiple recurrences are extremely common, and such is the natural course of the disease that it may be stated that an appendix once the seat of inflammation is likely to be again affected. As it is impossible to presage either the time or the severity of recurrence, a diseased appendix is a menace to life as well as to health as long as it remains in the body. This is true of all cases, whether they begin as an acute appendicitis or are chronic from the commencement. The prognosis as to health is even less unfavorable in some of the cases that are chronic from their incipiency than it is in some of the recurrent cases, because in the latter there are often periods of comparative comfort, or even good health, whereas it is not uncommon for patients with the former to be constantly ailing. After the appendix has been removed the prognosis as to subsequent health is, of course, excellent.

In the prognosis the results of possible peritoneal adhesions must be considered. If these have formed between the appendix and the surrounding structures,—such as the parietal peritoneum, omentum, cecum, colon, small intestine, bladder, pelvic organs, etc.,—they may give rise to a diversity of symptoms. The most important of these is intestinal obstruction, the consequence of the mechanical action of the adhesions. These adhesions sometimes also develop after operation for the excision of the appendix, and may necessitate a second operation for their correction.

TREATMENT.

The treatment of a case of appendicitis may be based upon one of two sets of principles that are popularly known as the medical and surgical respectively. That adopted in the individual case will depend in great measure upon the preconceived ideas of the attending physician or surgeon and upon various circumstances connected with the case. Personally, I may state that increasing observation and experience have confirmed me in the opinion that the most appropriate course to pursue in order that the best results be obtained is to remove the diseased appendix as soon as the diagnosis of appendicitis has been made—provided the diagnosis has been made early and there are no complications that render immediate operation unjustifiable. The appendix should be removed so early in the attack that sufficient time can not elapse for the supervention of septic absorption, perforation of the appendix, or purulent peritonitis; and in those cases of a fulminating character, in which the transit from the initial symptoms to the inauguration of purulent peritonitis the result of perforation or gangrene of the appendix has been most rapid, almost instantaneous, early operation is all the more urgently demanded.

It is essential that physicians appreciate the importance of early operation, as although there may be a few patients who for one or several reasons can not or will not have the benefit of operative procedure, the vast majority will depend upon the attending physician for advice. While it is impossible to formulate rules that shall govern the treatment of all cases of appendicitis, I am nevertheless convinced that it may be stated as a maxim that unless there be some constitutional contraindication, the appendix should be removed immediately if the diagnosis has been made early. In practice it will be necessary to depart from this rule in some cases for various reasons. It is a fact that a certain percentage of cases will temporarily recover without operative procedures; some patients even may never have but a single attack. But it is nevertheless true that no one can foretell which case will terminate favorably or which will progress to perforation or gangrene and the attendant peritoneal and other complications and sequels. The best results in all cases, however, are to be obtained by the removal of the appendix in the very beginning of the attack. Appendicitis is a surgical disease, and should be treated in accordance with the best dictates of surgical practice.

The first question that arises after the diagnosis of appendicitis has been established is that concerning the character of the attack, the nature of the pathologic processes at work, and the probable outcome. It is in this connection that we have to face a condition, not a theory. As already stated, we can not foretell with even the slightest amount of assurance the issue of an attack of appendicitis, nor can we be certain of the nature of the lesions of the appendix from the clinical manifestations. The main point to consider, then, is, Shall we risk the patient's life, or shall we adopt the only alternative and remove the diseased organ in its incipient inflammation? In this affection early operation is a conservative, not a radical, procedure. We are not governed by the same reasons that influence us to perform the radical operation for the cure of a simple hernia or for the removal of the uterus for a fibromyoma. In appendicitis we face the probable consequences of suppuration, gangrene, and perforation of the appendix and various lesions of the peritoneum. The proportion of patients who have but one attack of appendicitis and remain perfectly well after its subsidence is so very small as compared with the number of those who have repeated attacks, with intervals of more or less complete invalidism, that the rare exception should not interfere with the operation of the rule: that is, in all cases of appendicitis the diseased organ should be removed immediately if the diagnosis has been established early in the attack.

It is sometimes advised to delay operation until there is evidence of the presence of pus, and to defer it also if there be any doubt as to the pus formation. I could cite many cases in which the operation was delayed until there was unmistakable evidence of pus, some of them having been delayed so long that the patient was practically moribund when the surgeon was called. To defer operation a certain number of days, or even hours, except in some rare cases, is to expose the patient to risks not justifiable in the light of the present state of appendicular surgery. The best results and the lowest mortality-rate are obtained when the operation is performed at the earliest possible opportunity. Usually the diagnosis can and should be made in a few moments, and the operation should follow as soon as possible. It is hard to conceive why it should be advised to await the formation of pus, since this event adds greatly to the dangers of the operation, in that the most extensive absorbing surface—the peritoneum—is involved. One need but picture to himself the two operations—the one for the removal of the appendix without the association of pus, the other the excision of an appendix bathed in pus—to arrive at the only reasonable conclusion. In the first instance there is a clean abdominal incision; the appendix is readily removed; the opening in the wall of the cecum is sutured; and the abdominal wound is aseptically closed. In the second instance there is opened a collection of fetid pus which, in its escape, comes in contact with the incision and its contiguous parts; the appendix is excised under unfavorable circumstances and with the possibility of infection of the general peritoneal cavity; the abdominal wound can not be closed, but must remain at least partly or wholly open to afford drainage; and there is the subsequent tedious healing by granulation and the possibility of the later development of a ventral hernia. With these facts before us, I can not conceive how it can be held that we should await the development of pus before proceeding to operation. That delay is dangerous in the great majority of cases is certain; that a few patients will recover from the disease without operation can not be denied; that some patients will experience more or less subsidence of the acute symptoms must also be granted; but that any one can foretell the outcome of an attack I most emphatically deny. Those who are least decided upon the question of operation are they who have been limited in their experience. One must observe many cases in various stages of the affection to realize the dangers of delay, and must note the effects of the different methods of treatment to become convinced that the surest road to recovery is by means of early operation.

In stating as the principle of the treatment of appendicitis that the diseased organ should be removed immediately if the diagnosis has been made early, I am not unmindful of the fact that, speaking broadly, the attending circumstances are of great significance in determining the treatment to be adopted in many cases. It is sometimes impossible to institute early operative procedures for one of several reasons: the patient may not live within reach of a competent surgeon; he or his family may not be willing to have this treatment pursued until it has become evident that the patient's only chance of recovery is by operation; or there may be some serious underlying disease, such as advanced nephritis, diabetes, tuberculosis, etc., that forbids active measures. Under such circumstances expectant or so-called medical treatment is the only alternative. There is also another class of cases, in which, particularly in the hands of general practitioners, the treatment by medical, as opposed to surgical, means is the part of discretion. These are cases which at the onset do not bear the imprint of great seriousness, and which, following the institution of medical treatment, show marked improvement at the end of twenty-four hours, and continue to present steady improvement until evident convalescence is fully established. Many of these patients apparently recover entirely, though it is difficult to conceive that their appendices have returned to the normal condition. It is not really necessary that all these patients be subjected to immediate operation, provided that the attack be the first from which they have suffered and that the operation could not be performed under the most favorable conditions. If the medical treatment be adopted, constant watchfulness must be enjoined, strict attention must be paid to all the clinical manifestations and to the progress of the case, sound judgment must be exercised, and facilities must be at hand for immediate operation should alarming symptoms develop. The majority of such patients will probably recover from the acute attack; some, however, will develop suddenly alarming symptoms, and a few will probably die despite the most energetic measures to save their lives. It is for these reasons that early operation should be performed in all cases when possible.

The **medical treatment of appendicitis** comprises that appropriate during an attack and that to be practised during the intervals between attacks. The first includes the general management of the case, attention to the diet, local applications, and the administration of laxatives, enemas, and other medicinal agents if occasion warrant.

In the general management of the case it is most important to insist upon absolute rest in bed. As soon as the first indications of appendicitis manifest themselves the patient should go immediately to bed, and should remain there until complete recovery has resulted. He should be cautioned not to move about too much in bed, and strict quiet must be enjoined, in the early hours of the attack at least. Too early and too vigorous movement have been known to result in relapse of the condition, attended by most serious consequences. The general management of the sick-room does not differ from that appropriate in any other serious disease, but it is practically essential to have a reliable trained nurse in attendance.

The diet demands careful attention, and it is conducive to the welfare of the patient if the physician gives specific directions as to the kind of nourishment to be given, as well as to the time and the amount at each feeding. During the first few hours of the attack all nourishment must be withheld. If vomiting persist, as it does in some severe cases, no nourishment should be administered by the mouth. The endeavor should be first to restrain the vomiting. In the mean time, if the patient's condition necessitate it, rectal enemas should be administered. These may consist of from four to six ounces of peptonized milk, to which may be added the whites of one or two eggs and half an ounce of whisky. Such enema may be administered every four hours or thereabouts, according to the circumstances of the case; each enema should be preceded about half an hour by irrigation of the rectum and colon with water or normal salt solution. After the vomiting has ceased, food may be given in small amounts at rather frequent intervals. It is well, however, for the first few days of the attack not to give more food than the condition of the patient requires, and that which is given should be such as is digested in the stomach or upper intestinal tract, is nonflatulent, and leaves little if any residue in the bowel. Liquid food alone should be given, and choice may be made of the following: Milk (preferably peptonized or pancreatized), broths, beef-tea, and malted foods. Natural milk, as a rule, is contraindicated, because of the likelihood of the formation of indigestible curds, and because it tends to constipation and tympanites. In the early hours of the attack hot milk, broths, beef-tea, etc., will be found to agree better with the patient than cold drinks. Later on, however, the milk, etc., may be given cold, if thus more grateful to the patient, and buttermilk and beaten eggs may be added to the dietary. A small amount of weak tea may also be permitted, if specially desired by the patient. Thirst, if present, may be combated by small bits of cracked ice allowed to dissolve in the mouth and then expectorated; in some cases also by teaspoonful doses of hot water or by rectal injections of normal salt solution. During the early days of the attack the nourishment should be administered every two hours, and the quantity should not exceed two or three ounces. As convalescence becomes established the quantity may be increased and the intervals lengthened, and calf's-foot jelly, milk-toast, eggs (soft-boiled or poached), etc., may be added. The return to ordinary diet should be gradual. After convalescence and in cases of chronic appendicitis the diet must be chosen with especial care, and must be easily digestible.

Of the local applications which when applied to the right lower abdominal quadrant exert a favorable action, an ice-bag is by far the most suitable. The use of the ice-bag should be commenced in the incipiency of the attack, and it may be kept on continuously until convalescence is well established. Dry cold, in the form of an ice-bag or a Leiter's coil, is much preferable to moist cold; it acts as a local anesthetic, and, if applied early, modifies the degree of inflammation and thus hastens resolution. It must not be lost sight of, however, that the too prolonged use of cold may result in superficial necrosis of the skin and subcutaneous tissues. Occasionally hot applications will be found more grateful to the patient, and selection may be made of a hot-water bag, various sorts of hot fomentations, turpentine stupes, etc. The topical application of tincture of iodin, blisters, leeches, and other forms of counterirritation is especially contraindicated, not only because they do no good, but because they add materially to the patient's discomfort. Blisters and leeches are especially objectionable because of the macerating effect they exert upon the skin, thus making a septic field for operation, if such be undertaken.

The most important feature of the treatment of a case of acute appendicitis is the prompt administration of a laxative. In the event of an acute appendicitis having developed or the clinical manifestations being suggestive of such affection, it is imperative that the bowels be evacuated immediately, and an effort should be made to secure at least several stools. Many an attack which, if permitted to progress unmolested, would develop into one of great seriousness, may be aborted or considerably modified by the prompt administration of an efficient laxative and the thorough evacuation of the bowels. The presence of diarrhea is not a contraindication to the administration of a laxative, as the latter is generally as urgently demanded when diarrhea is present as when there is constipation. A laxative serves a threefold purpose: (1) It relieves the pain by clearing the intestinal tract of all irritating and stagnant material; (2) it induces an active peristalsis in the intestine and appendix, and thus assists the latter to rid itself of its contents—virulent micro-organisms, possibly appendicular calculi, muco-purulent material, etc.; (3) it diminishes the virulence of an attack by helping the evacuation of the appendix and by removing all irritating and stagnant feces from the intestine, particularly from the cecum and the adjoining areas, where, by its presence, it facilitates the multiplication and the increase in the virulence of the micro-organisms.

Of the laxatives, preference should usually be given to castor oil. It unloads the bowel without causing an outflow of serum from the intestinal circulation. Castor oil, however, is particularly distasteful to some patients, and the presence of nausea and vomiting in others sometimes prohibits its use. Under these circumstances saline cathartics or calomel should be given. To some patients who have early and persistent nausea, with or without vomiting, it is advisable immediately to administer calomel, taking advantage of its dual action—that of allaying the irritability of the stomach and that of producing catharsis. The best method of administering calomel under these circumstances is in the powdered form ; compressed tablets or triturates are popular with some practitioners, but they are not so serviceable as the powder, and, particularly, if not freshly made, they are not only likely to be insoluble and inert, but they may also cause mechanical irritation of the stomach and provoke further emesis, thus defeating the object for which they were administered. The calomel may be given in doses of from $\frac{1}{20}$ to $\frac{1}{4}$ of a grain every fifteen minutes or every hour until one or two grains have been taken. The addition of a little bicarbonate of sodium to each powder will hasten the laxative effect of the calomel. If free catharsis be not obtained after the lapse of several hours, a Seidlitz powder or a small amount of Rochelle or Epsom salts will usually accomplish the desired result. At times small and repeated doses of calomel will fail to alleviate the irritation of the stomach, in which event a single large dose (from five to ten grains, repeated in an hour if necessary) will often have the desired effect. If nausea still persist, a small fly blister applied immediately below the ensiform cartilage will often prove of decided service. In other cases Rochelle or Epsom salts, given in the beginning of the attack, will be found most useful. It is particularly in the later stages of the affection, however, when peritonitis has supervened and depletion of the intestinal tract is most desired, that these salts find their special field of usefulness. They may be administered in small doses, repeated every hour, until free and thorough evacuation of the bowels and a number of watery stools have resulted.

The indications for the administration of enemas are the same as those that call for the exhibition of laxatives. The former, however, should be given only as an adjunct to the latter, and never to their exclusion. Administered early in an attack of appendicitis, they often materially assist the laxative in at least ameliorating the severity of the inflammatory phenomena. Usually a single enema suffices, but at times it may be found advisable to give an enema daily or every other day. The enema may consist of a pint of warm water and soap; late in the attack the addition of two fluidrams of turpentine will often be found efficacious in promoting evacuation of the bowels and lessening tympanites. Forced enemas should never be given with the idea of overcoming persistent constipation, which is frequently dependent upon a paralytic condition of the intestines. Such constipation is sometimes an expression of perforation of the appendix, and a forced enema administered under such circumstances may be injected into the peritoneal cavity—an accident that occurred in a case reported in the first edition of this treatise.

In many cases of appendicitis in addition to the foregoing no medication is called for—the attack will terminate in apparent recovery. This becomes less likely with increase in the number of previous attacks, and, despite the best-directed management, many cases of primary seizures will progress to perforation, or to gangrene of the appendix, with peri-appendicular suppuration or diffuse peritonitis. And it is impossible to foretell in the incipiency of the attack which cases will thus eventuate. It is the part of discretion to limit medicinal treatment to primary seizures, and if in any attack medical treatment be adopted, either through choice or necessity, the attending physician must be ever watchful for unfavorable symptoms that may arise at any moment, and he must be prepared, at an instant's notice, to himself perform the inevitable operation or have a surgeon in readiness to do so for him. Remedies such as veratrum viride, aconite, various fever mixtures, etc., are not indicated, and should be withheld. Nor is the administration of salicylic acid and its various salts to be commended. Good effects have been claimed for these, particularly by those who maintain the rheumatic nature of some cases; but neither this etiologic relationship nor the good effects of the suggested therapy have been part of my experience. Asafetida suppositories, however, will often be found of extreme value in alleviating pain and in assisting intestinal peristalsis and the expulsion of flatus.

In this connection it seems appropriate to make a few remarks concerning the diverse views expressed by different writers upon the advisability of administering laxatives or opium in the treatment of appendicitis. A number of eminent observers have testified to the inadvisability of the administration of laxatives in the early stages of appendicitis, but experience has taught me that, on the contrary, it forms the most successful, and therefore most appropriate and justifiable, treatment when operation can not be performed. I do not hesitate to offer it to my readers as sound and rational therapeutics. As already stated, laxatives should be administered early in sufficient quantity to secure free and thorough evacuation of the bowels. They accomplish the most good when given early, before adhesive inflammation has resulted in agglutination of neighboring coils of intestine, omentum, mesentery, etc.,—the method whereby nature imprisons the inflamed appendix and tends to prevent infection of the general peritoneal cavity in the event of perforation of the diseased organ. I am certain, also, that in the presence of commencing adhesive inflammation surrounding the appendix and its neighborhood there is less danger attendant upon the free evacuation of the bowels than may supervene if the bowels be permitted to remain overloaded with stagnant feces. The benefit that accrues from clearing the intestine far outweighs the possible danger that may follow the breaking-up of peritoneal adhesions that may be forming. In the later stages of the disease, after the fibrinoplastic barrier that protects the general peritoneal cavity from the inflamed and septic appendix and from possible peri-appendicular suppuration has been formed, purgation is held by some to be inadvisable because of the likelihood that the peristaltic movements of the intestine may break down nature's safeguard against the spread of the infection. It has, however, been my practice to administer laxatives in all cases, except in the presence of an acute exacerbation of the symptoms suggestive of perforation or gangrene of the appendix. Such have been the results of this treatment that I warmly commend it to my readers.

Impressed as I am with the advisability of the administration of laxatives in the treatment of appendicitis, I can testify with equal force and conviction to the dangers attendant upon the administration of opium and its various preparations. Of all the therapeutic agents that have been used in the treatment of appendicitis, opium is the one that has been most frequently responsible for mistakes in diagnosis, and there is a percentage of deaths in appendicitis that, beyond doubt, is due to the indiscriminate and injudicious use of this drug. The administration of opium in the treatment of appendicitis can not be too strongly condemned, for the following reasons:

1. It masks the symptoms. In a disease such as acute appendicitis, in which the onset is sudden and severe, in which the pathologic alterations are taking place with extreme rapidity, and in which the symptoms and signs are frequently irregular and in no way proportionate to the severity of the anatomic lesions, it is most desirable, in fact imperative, that the physician be constantly and correctly informed as nearly as possible of the state of affairs. As a rule, the pain and tenderness are in proportion to the intensity of the lesions. If, therefore, they be masked by opium, the physician may be deceived or led to believe that the attack is subsiding, whereas the lesions may be gradually or rapidly progressing to perforation or to gangrene and fatal peritonitis.

2. It favors the retention in the appendix and intestine of excrementitious material. The early pain of an attack of appendicitis is frequently caused, in part at least, by an ineffectual attempt on the part of the appendix to empty itself of its contents. This attempt is facilitated and assisted by the evacuation of the general intestinal tract, and as opium inhibits or prevents such evacuation, its administration defeats nature's efforts to remove one of the exciting causes of the attack of appendicitis.

3. It decreases the functional activity of the stomach, intes-

tine, liver, kidneys, lungs, and skin at a time when elimination of waste products is imperatively demanded.

4. It causes distention of the bowel by paralyzing the muscular coat, and thus prevents the intestine from overcoming the expansion of putrefactive gases and favors general tympanites, with its distressing symptoms.

5. As a consequence of the intestinal distention coils of the bowel are pushed and thrust into the area of inflammation, and the spread of peritonitis is thus facilitated.

6. By the distention of the intestine which it engenders it further assists the progression of the peritonitis, as micro-organisms more readily pass through the walls of a distended bowel, and one therefore reduced in vitality, than through a normal intestine.

7. It lessens the patient's susceptibility to pain, but does not remove the cause of the pain.

8. It increases nausea when it is present and induces it when it is absent.

9. It decreases the phagocytic action of the blood elements in the struggle against invading pathogenic micro-organisms, and thus tends to favor suppurative processes and their attending consequences.

10. It decreases the power of the lymphatics to take up and destroy the poisonous products of bacterial activity.

11. It induces a false hope that buoys up the patient and physician—a hope of recovering without operation. Very frequently this state of well-being leads to postponement of the inevitable operation until the poor sufferer is beyond the reach of human endeavor.

On the contrary, it is claimed by the advocates of the opium treatment that this drug relieves the pain, and, by the inactivity of the intestine that it induces, favors adhesive inflammation of the peritoneum, and thus permits of the protection from infection of the general peritoneal cavity. As already stated, opium lessens the patient's susceptibility to pain, but it does not remove or mitigate the severity of the anatomic lesions. The advent of suppuration is an unfortunate complication—one that can usually be avoided by prompt surgical treatment of an attack of appendicitis, and one that, when present, demands immediate operation. The pain of appendicitis can usually be controlled by thorough evacuation of the bowels, the application to the right lower abdominal quadrant of ice-bags, and, if necessary, asafetida suppositories. It is often remarkable that complete relief, or at least great amelioration, of the pain follows the free evacuation of the bowels; and the administration of opium, originally considered urgent, is found to be uncalled for. In some cases, however, after a period of more or less relief following the evacuation of the bowels, the pain returns with increased intensity. This constitutes one of the most urgent indications for immediate operation, as it generally indicates perforation of the appendix. If opium has been administered in such a case, perforation of the appendix and consequent peri-appendicular suppuration may occur, unheralded by clinical manifestations, and the patient may die in the uncomplaining quiescence of an opium stupor. In view of these facts it seems desirable—and experience confirms me in the opinion that it is wise—to abstain from the use of opium, and to employ the medical treatment already detailed when the surgical or operative treatment can not be carried out.

In discussing the **surgical treatment of appendicitis** it must be stated that the medical treatment, as already narrated, is indicated, and should be inaugurated, in all cases which it is proposed to subject to operative measures. When, however, the diseased appendix is removed early in the attack,—that is, within the first twenty-four hours, or, preferably, within the first twelve hours,—the attack is at once terminated, the patient is subjected to the least possible immediate risk, and the remote complications are avoided. Among the latter may be mentioned perforation, gangrene, abscess formation, general peritonitis, fecal fistula, protracted convalescence, secondary operation, and the long list of complications referred to in the chapters on the Pathology and on the Complications and Sequels. When marshaling the evidence that decides us in favor of an early operation, we must bear in mind that, as already stated, it is impossible in the vast majority of cases to form a clear conception of the lesions of the appendix from the clinical manifestations. If the initial symptoms be severe, we may surmise a severe infection, and prompt surgical interference is imperatively demanded. On the other hand, apparently mild cases are often most deceptive as regards the lesions of the appendix. With a low pulse-rate, normal temperature, diminution or cessation of pain, and lessened tenderness and rigidity, ulceration of the appendix, progressing to perforation and gangrene, may be making rapid headway. Operation under such circumstances is, of necessity, performed with much-increased risk to the patient, and always offers a less promising outlook. An operation in the early hours of an attack of appendicitis is inadvisable only in the presence of some constitutional condition that would forbid the performance of any operation. Unwillingness of the patient or of his friends, while a valid reason for delay, does not alter the indications for operation.

Operation is contraindicated in those cases of diffuse peritonitis in which the abdomen is distended, the temperature high, the pulse rapid and of high tension, the patient's expression most anxious and indicative of very serious intra-abdominal infection, the bowels constipated and unable to cause the expulsion of flatus, and in which vomiting is continuous, and tenderness is diffused over the entire abdominal wall. The presence of tympanitic distention of the epigastrium, when associated with regurgitant vomiting, is indicative of approaching dissolution, and is, in consequence, a contraindication to operation, as is also the ordinarily well-recognized collapse. It is useless to subject the patient to additional pain and discomfort without being able to offer even a remote chance for recovery, which I think impossible in these cases. The application of ice to the abdomen, a small fly blister just below the ensiform cartilage, the internal administration of calomel to the extent of causing free evacuation of the bowels, nutritious enemas, stimulants, such as whisky, dry champagne, and strychnin hypodermically, in this class of cases promise much more than does operative treatment. When, as a consequence of these measures, the peritonitis subsides and the constitutional condition warrants it, operation may be undertaken with hope of a successful issue.

If the time of election—that is, the early hours of the attack—have passed, when the symptoms recur, or when they increase in severity, or if there be no improvement, particularly if the tenderness persist, the appendix should be removed without delay.

If an attack of appendicitis be attended by the development of pus, the diseased organ should be removed at the earliest possible moment. The practice of deferring operation for a few days, in the hope that the limiting membrane that forms the partition between the collection of pus and the general peritoneal cavity will become stronger, is a procedure that is unwise and attended by risks both immediate and remote. The immediate risks are general septic infection, metastatic abscesses, pylephlebitis, abscess of the liver, etc. The remote risks are gangrenous perforation, spontaneous separation of the appendix from the cecum, spontaneous division of the appendix in its continuity, necrosis and perforation of the cecum from pressure of the suppurative focus against its wall, fecal fistula, etc.

The appendix should be removed at the primary operation in all but exceptional cases. That the appendix should be removed is an opinion concurred in by all surgeons who have had experience in this class of operative surgery; they differ only as to the time of election. At the primary operation the proper disposition of gauze to protect the general peritoneal cavity—the most important part of the operation—renders the removal of the diseased appendix entirely safe, and it is certainly most advisable. I consider that in general the danger to the patient of leaving a diseased appendix in the abdominal cavity is greater than the damage likely to accrue in experienced hands from rupturing the limiting fibrinoplastic wall in an endeavor to remove it. It is possible and generally advisable to remove the diseased appendix, thus insuring complete recovery, which is to be attained by no other means. I must, however, emphasize the fact that it would not be just to humanity for me to advise the occasional and inexperienced operator to remove the appendix in all cases. I realize the importance of the operator being thoroughly familiar with surgical anatomy and technic in order that a successful issue be the outcome in these cases. I maintain, though, as a surgical principle, that the removal of the appendix in all operable cases is the proper procedure in the hands of experienced surgeons; qualifying this statement by the following observations: There is but one constitutional contraindication to the removal of the appendix, and that is collapse of the patient; the removal of the appendix is also unwise in those cases in which it has formed adhesions with soft friable intestines, or when such intestines have formed adhesions among themselves—the slightest manipulation in some of these cases being sufficient to cause a rupture of the intestines; in children, also, in some exceptional pus cases, it is good surgery to permit the appendix to remain for excision at a secondary operation, because the position that the appendix holds in children is higher in the abdomen than it is in the adult; because the small size of the abdominal cavity in children renders the walling-off by gauze of the unaffected portion of the peritoneum extremely difficult, or even impossible; and because children do not stand prolonged anesthesia well. While it is far safer for the patient that the occasional operator content himself with the evacuation of the abscess, the experienced surgeon should be able to and should remove the appendix in all cases with the exception of those just cited. To leave within the abdomen an appendix that has sloughed off, or one that is perforated or intensely inflamed as a consequence of infection by virulent micro-organisms is incomplete surgery. An appendix that is embedded in a wall of lymph, whether it form a portion of the abscess wall or not, can be removed with comparative safety, providing the operator has had sufficient experience and is dextrous in the treatment of this class of cases. The proper disposition of gauze and careful attention to other technic, in experienced hands, render the dangers that attend the removal of the appendix much less than those that threaten the patient if the diseased organ be permitted to remain. A practice that is rather common is that of evacuating the abscess and, after affording drainage, partly closing the wound, without attempting the removal of the appendix unless it lie in plain view. If the surgeon be familiar with the anatomy of the right iliac fossa in the normal condition, and has seen a sufficient number of cases to make him acquainted with the conditions generally found in diseased states, he should be able to find the appendix in all cases. The search, however, is sometimes tedious and attended by difficulty.

Although the **technic of the operation for appendicitis** varies with the nature of the case, and with the conditions present at the time of operation, there are, nevertheless, certain procedures that should be carried out in all cases when feasible.

In acute cases the patient is usually in bed, and if the attack be but several days old, his diet should have been *nil* or light and easily digested, and with a minimum of residue. In chronic cases the patient should be confined to bed for one or two days preceding the time set for operation, and his diet also should be light and easily digested. The urine should be carefully examined at least once, and oftener if time permit. This measure should never be neglected. If the case be a chronic one, the day preceding operation the patient's bowels should be evacuated by a laxative, and on the morning of the operation an enema should be given.

The patient should be prepared for operation as follows: If the case be a chronic one and time permit, he should be given a general bath with hot water and soap, followed by thorough rinsing with a saturated solution of boracic acid. An entire change of the personal clothing of the patient and of the bed linen should be made. The immediate site of the operation should be scrubbed with thymol or green soap, hot water, and a soft brush, particular attention being paid to the umbilicus. The field of operation should be shaved, so that hair, dead epidermis, and dirt may be removed. The abdomen should then be rescrubbed with soap and water. This should be followed by the successive application of ether and alcohol upon a wad of aseptic cotton in order to remove any fatty material. Lastly, a thorough scrubbing with corrosive sublimate, of the strength of 1 : 1000, should be made. A sterile towel or a large piece of gauze moistened with the sublimate solution should next be placed upon the abdomen and retained by a bandage. The patient is then ready to be placed upon the table on the following day, if he be not operated upon immediately. After etherization and the arranging of sterile sheets and towels, the abdomen should be again washed with 1 : 2000 bichlorid solution. The operation may then be proceeded with. Of course, it is not always possible to carry out this detailed preparation in all cases. It not infrequently happens that the operation has to be done at once or under other unfavorable circumstances.

The two **incisions** which are most suitable for the operation of appendicitis are those which go through the abdominal wall to the right of the median line. They are the simple and the McBurney incision. The median incision for appendicitis operations is not founded on good anatomic grounds; it is irrational and dangerous, particularly if pus complicate the case.

The *simple incision* divides the layers of the abdominal wall in the same longitudinal line. It may be directed through the right semilunar line or to the inner side of this line and through the rectus muscle. The length of the incision must be governed by the conditions present in each individual case.

In pus cases, when the purulent collection is circumscribed and is situated well toward the spine of the ilium, it is often advisable to make the incision well to the right, running parallel with and just above Poupart's ligament. This incision under these circumstances usually permits of better drainage and greatly decreases the danger of breaking through the inner wall of the abscess cavity in the manipulations necessary for the removal of the appendix.

The incision in the peritoneum at first should be but one inch in length—merely large enough for the insertion of the index-finger. Through this incision the cecum may be seized and brought out through the wound, and with it the appendix should also be delivered. If the cecum or appendix be bound down by adhesions, or if pus be present, an attempt to deliver the cecum and appendix should not be made, but the peritoneal incision must be enlarged. Bleeding should be controlled with hemostats before the peritoneum is opened.

McBurney's incision is slightly more complicated than the simple incision, but is appropriate only in cases unassociated with pus. It is less likely to be followed by ventral hernia than is the simple incision made through the linea semilunaris, but in this particular it possesses no advantages over the simple incision through the rectus muscle.

Whichever incision be practised, as soon as the peritoneum is opened, the cecum should be withdrawn or delivered from the abdominal cavity. and with it the appendix, if it be not adherent. After the appendix is in the grasp of the thumb and finger the cecum should be replaced within the abdominal cavity. The appendix should then be amputated with a pair of scissors flush with the cecum, and the opening thus made in the latter should be closed with Lembert sutures. When the appendix is gangrenous or very friable, or is much involved in the inflammatory fibrinoplastic exudate, we often have to content ourselves with a simple ligature taking in all the coats of the organ.

Very often in cases that are complicated by the presence of pus there is no confining wall of fibrinoplastic exudate; or if such be present, it is either incomplete or so delicate that the cecum or appendix can not be exposed without subjecting the general peritoneal cavity to the danger of infection. It is, therefore, a matter of extreme importance that some method be devised whereby the spread of the infection will be rendered impossible during the manipulations necessary for the removal of the organ. This is conveniently and thoroughly accomplished by the proper disposition of sterilized gauze.

Since the success of the operative treatment of appendicitis complicated by pus formation depends largely upon a knowledge of the anatomic varieties of peri-appendicular abscess, as well as upon a complete comprehension of the safest method of evacuating the pus and removing the appendix without infecting the general peritoneal cavity, a brief description of the operative technic to be practised in each instance may be given.

Depending upon the location of the pus, peri-appendicular abscess is met with as one of five varieties: First, and the most common in my experience, is that in which the collection of pus is located post-cecal or between the layers of the ascending meso-colon; second, that in which the collection is immediately beneath the anterior parietal peritoneum, being confined by the cecum, coils of small intestine, the omentum, the appendix and parietal peritoneum, and masses of inflammatory lymph; third, that in which the collection is located in the pelvis, when it is usually entirely shut off from the general peritoneal cavity; fourth, that in which the collection is located near the median line of the abdomen and to the median side of the cecum; fifth, that in which the pus is free in the general peritoneal cavity.

In dealing with the first variety, as soon as the peritoneum is incised the general peritoneal cavity should be protected from infection by the proper disposition of gauze, which should be in large amount. The abscess should then be opened by breaking through either the outer layer of the ascending meso-colon or through the layer of lymph that attaches the outer wall of the cecum to the floor or the side of the iliac fossa. The abscess cavity should then be wiped out, first with dry iodoform gauze, then with gauze wet with either a solution of bichlorid of mercury or carbolic acid. The appendix should then be located and removed. Drainage, consisting of either narrow strips of iodoform gauze or a rubber drainage-tube, or both, should then be introduced to the bottom of the abscess cavity, and the abdominal wound should be closed with the exception of the site of the exit of the drain. In some cases the wound should be left entirely open. After the lapse of from forty-eight to seventy-two hours or longer the drainage should be removed, and the wound permitted to heal by granulation.

The evacuation of a collection of pus located behind the cecum and the colon necessitates opening the general or larger of the two peritoneal cavities, unless an incision be made through the loin, such as is made for the liberation of a nephritic or perinephritic abscess. This method would suffice if the exact location of the purulent collection were previously known, and the operator's intention were merely to evacuate the abscess and not to attempt the removal of the diseased appendix. The operator who believes it bad practice to remove the appendix in pus cases unless it appears in view or under the finger, after having made the incision from in front and discovered that the collection of pus is in this situation, may, if he chooses, close the anterior incision and then proceed to perform the loin operation. It is unnecessary to state, however, that this would subject the patient to an incomplete operation, and it is certainly not to be commended. In a percentage of these cases of post-cecal collections of pus through-and-through drainage is indicated. A rubber drainage-tube running through the anterior incision and coming out through a counter-opening made through the loin may be requisite for the necessary drainage.

In the treatment of the second variety of peri-appendicular abscess, immediately upon carrying the incision through the parietal peritoneum the collection of pus is opened. The pus cavity should be evacuated and antisepticized without irrigation. Irrigation in this variety of abscess is attended by danger on account of the delicacy of the confining wall, which renders dissemination of infectious material a matter very easy of accomplishment. Evacuation of the abscess is ordinarily effected without risk of infecting the peritoneum, since the incision that corresponds to the most prominent part of the swelling, or, if no swelling be present, to the point over the involved region most tender to pressure, comes directly down upon the purulent collection. This variety of abscess can usually be said to be present when the abdominal muscles along the line of the incision are found to be the seat of inflammatory edema and infiltration. If the muscles are not thus affected, the abnormality will be found in the transversalis fascia and the preperitoneal fat. Unless the case be of several days' standing, the amount of pus in this variety of abscess is small as compared with that generally encountered in the first variety of peri-appendicular abscess. It is, therefore, readily disposed of by mopping with pieces of iodoform gauze. The peritoneal cavity should now be protected by gauze, introduced through the original incision or through a secondary one to the median side of the original one. After the appendix has been located it should be dissected free, and as it is loosened from its confining bed small pieces of iodoform gauze should be so introduced that, when the appendix is entirely free, its original site is occupied by the gauze. The appendix can then be excised, and the abscess cavity and abdominal wound should be treated as in the first instance.

In this second variety of abscess it frequently happens that the collection of pus is not completely confined at its lower end, but is in communication with the pelvis. I make it a practice, therefore, to pass a glass drainage-tube down to the floor of the pelvis definitely to determine the presence or absence of pus. On many occasions when operating upon this variety of peri-appendicular suppuration, I have evacuated but a dram or two of pus upon opening the peritoneum; but upon passing a drainage-tube into the pelvis, as much as half a pint of pus has escaped.

In operating upon the third variety of peri-appendicular abscess the peritoneal cavity should be walled off by gauze down to the roof of the pelvis before an attempt is made to treat the appendix or the abscess. After the proper disposition of gauze the finger should be carried over the brim of the true pelvis down into the collection of pus, and, with the finger as a guide, a glass drainage-tube should be introduced. The abscess should then be irrigated, and the appendix should be located and excised. After the removal of the diseased organ the glass drainage-tube should be reinserted and, in addition, gauze drainage should be provided. The gauze should be permitted to remain until adhesions that will close off the abscess cavity have formed—usually from twenty-four to forty-eight hours. In some cases, if the patient be convalescing favorably, the gauze may be permitted to remain five or six days. The glass drainage-tube may remain in place from one to four days, depending upon circumstances. The upper portion of the abdominal wound should be closed; the lower, through which protrude the glass tube and the gauze, allowed to remain open, and subsequently to heal by granulation.

The evacuation of this or the pelvic variety of peri-appendicular suppuration through the vagina or rectum I regard as opposed to the dictates of sound surgical practice, and as attended by more risks to the patient than the operation through the abdominal wall. By the latter means the true condition of affairs is definitely determined, nothing is taken for granted, and the operative procedures are directly under the control of our various senses. In particular, the appendix can be removed at the time of the primary operation—a procedure that I regard as extremely important. Of all varieties of appendicitis attended by suppuration, these cases of pelvic suppuration due to appendicitis have been, in my hands, among those most successfully treated by operation.

In the fourth variety of peri-appendicular abscess the collection of pus lies to the inner side of the cecum, and the confining wall is made up of the cecum, appendix, small intestine, mesentery, omentum, and possibly the sigmoid flexure. At times, also, the purulent collection is found retro-mesenteric. In operating upon these cases, after the primary incision in the usual situation has been made, a secondary incision toward the median line of the abdomen is generally necessary to insure the proper disposition of the gauze for the protection of the general peritoneal cavity. The further operative procedures are similar to those already detailed.

In the treatment of the fifth variety of abscess, or diffuse purulent peritonitis, the general peritoneal cavity should be thoroughly irrigated, the appendix removed, a glass drainage-tube introduced into the pelvis, and the abdominal wound closed. If the case be of sufficiently long standing to have permitted of the formation of extensive adhesions throughout the general peritoneal cavity, the adhesions having been disposed of, it may be necessary to provide capillary drainage by means of strips of gauze distributed in various directions between the coils of intestine. Irrigation in these cases is not sufficient to cause the dispersion of infectious material from the numerous recesses of the peritoneal cavity, particularly when these are further increased by various adhesions. It will be necessary, therefore, in many cases to disembowel, cleanse, etc. In some instances such conditions are met with very early after the onset of the first manifestations of the attack, and I have encountered them at the end of twelve hours. These cases are very virulent from the onset, and call for immediate operation.

In cases in which there has been no attempt upon the part of nature to wall off the pus, or in which there are no adhesions between the anterior layer of the peritoneum, the omentum, and the underlying intestine, it may also be necessary to insert a series of pieces of gauze in such a manner that they will drain the general peritoneal cavity. This is accomplished by introducing each piece lengthwise between certain coils of intestine and permitting the outer end to protrude from the abdominal wound. In closing the wound the stitches between which the ends of the gauze project are to be left long, so that they may be tied after the removal of the gauze.

In the treatment of the first four varieties of peri-appendicular abscess skilful manipulation is required in order to remove the appendix without infecting the general peritoneal cavity. In the first and third varieties—that is, the post-cecal and the pelvic collections—equal care must be exercised to avoid infecting the peritoneum during the evacuation of the abscess. In the fifth variety little or no difficulty should be experienced in finding and removing the appendix, as the anatomic landmarks are but slightly, if at all, altered or distorted by the inflammatory processes.

In closing the abdominal wound one of several methods may be employed: (1) Interrupted sutures including all the layers of the abdominal wall; (2) buried sutures uniting the different layers of the abdominal wall individually; and (3) a combination of both methods. The method of election depends upon whether or not drainage has been used. When drainage is employed, I use the simple interrupted through-and-through sutures of silkworm-gut. As a rule, this is the preferable suture. It insures the most perfect coaptation of the opposed surfaces of the wound and, obliterating as far as possible all spaces that might otherwise remain, lessens the likelihood of infection of the wound. In cases in which drainage is not employed, therefore, in those cases in which the wound can be closed in its entirety, it is well to employ both the interrupted through-and-through suture and the layer or tier suture

—securing the combined advantages of both. The sutures employed comprise three sets. The first should consist of a continuous catgut or silk suture to close the peritoneum. The second should consist of interrupted silkworm-gut sutures, which should be introduced through the skin and all the subjacent tissues down to, but not including, the peritoneum. These should not be tightened until after the introduction of the third set, which should consist of a continuous catgut suture to close the anterior sheath of the rectus muscle. After this has been properly tied the set of interrupted silkworm-gut sutures should be tied.

A rather frequent accident in closing the simple abdominal incision is a puncture of one of the deep epigastric veins. I am aware of a case in which such an occurrence led to the death of the patient from hemorrhage. If this accident occurs, the surgeon is not justified in closing the wound until the vein has been ligated. The deep epigastric veins can be exposed by lifting upward and drawing backward the rectus muscle, separating it from the fascia transversalis, beneath which the veins course. Remembering this fact, it is a simple matter to find and ligate the injured vessel.

Some surgeons prefer the straight round needle, deeming its use less likely to lead to puncture of the vessels just mentioned. Personally, however, I prefer the straight spear-pointed needle, or the curved needle on a handle, as both are easier to manipulate, and I believe their use is not attended by any increased dangers of puncturing the vessels.

The **after-treatment** of a patient operated upon for appendicitis is of the utmost importance, and his welfare depends upon close attention to details. The *general after-treatment*, applicable to all cases, is the following: The patient should be isolated and should be under the charge of a competent trained nurse. The temperature, the pulse-rate, and the respiration-rate should be recorded at least twice a day. They may be recorded oftener if the necessary procedures do not annoy the patient or if there arise special indications that render it advisable. The patient should be kept warm by the proper disposition of hot-water bottles, hot-water bags, hot bricks, or, if these can not be procured, by small bags of heated salt. It may be wise to protect the abdominal walls against pressure of the bed-clothes by a bed-cradle. If great pain be referred to the back, as is sometimes the case, much comfort may be afforded by pressure of the nurse's hands against the painful region, or by the placing of a hard pillow under the small of the back.

The after-effects of the ether, such as vomiting and tossing about in bed, should be carefully guarded against, and strict attention on the part of the nurse must be enjoined. If great restlessness develops, it may be necessary to fasten the knees of the patient together and to administer an enema of bromid of sodium or potassium (1 dram) and chloral (from 20 to 30 grains). These may preferably be given in two ounces of milk. The urine should be withdrawn by catheter if necessary. This, however, is rarely called for, and is not to be recommended, not only on account of the possible pain attending the procedure, but also because of the danger of exciting a cystitis. A catheter-cystitis is capable of giving rise to very much more discomfort than is the operation for appendicitis itself ordinarily.

If stimulation should be necessary, hypodermic injections consisting of strychnin (from $\frac{1}{40}$ to $\frac{1}{30}$ of a grain), atropin ($\frac{1}{240}$ of a grain), and whisky (one hypodermic syringeful) may be employed. They should be repeated as frequently as the circumstances of the case may indicate. Neither opium nor any of its preparations should be given. Absolutely nothing should be given by the mouth until after the ether-vomiting has ceased. Afterward small pieces of ice may be allowed at intervals of ten or fifteen minutes, and the mouth and lips should be kept cool by moistening with a wet cloth. An ice-bag to the head will often be found very grateful to the patient.

No nourishment should be given until the lapse of at least eighteen hours after the operation. If at the expiration of this time the stomach shows no evidence of irritability, tablespoonful doses of peptonized milk (cold process), with a tablespoonful of whisky, if necessary, or milk with lime-water, may be cautiously given every hour or two. The stomach remaining tolerant, larger quantities of milk may be given—one or two ounces every two hours, and the quantity increased or decreased according to circumstances. In addition to milk, if the stomach remains retentive, chicken broth, bouillon, liquid beef peptonoids, beef peptones, dry champagne, etc., may be administered. If vomiting should come on, absolute abstinence from food and liquids, for a time at least, will again become necessary.

If abdominal distention and inability to pass flatus should occur, asafetida suppositories or enemas of milk of asafetida should be administered. If these are not followed by the desired result, the nozle of a rectal syringe or a rectal tube should be introduced into the rectum. These failing, two or more ice-bags should be applied to the abdomen. These often serve to stimulate peristalsis, and thus favor the expulsion of the flatus.

If the patient does well, the bowels need not be disturbed until the third or fourth day after the operation. They may then be moved by a simple enema, a dose of Hunyadi water, Rochelle salts, phosphate of sodium, Epsom salts, or citrate of magnesium. In some cases it will be found advantageous to administer calomel in doses of from $\frac{1}{20}$ to $\frac{1}{6}$ of a grain every hour or two until the bowels move or until not more than two grains have been taken.

Persistent vomiting—which may develop in any case—should be treated by the application of a cantharidal blister (two inches square) to the epigastrium; by the administration of cocain in doses of from $\frac{1}{8}$ to $\frac{1}{6}$ of a grain every two hours; or by teaspoonful doses of hot, strong, black coffee every half hour. In some cases iced champagne will be found of service. During the persistence of the vomiting no food whatever should be given by the mouth; if necessary to maintain the patient's strength, resort must be had to rectal nutrient enemas.

For the relief of the post operative pain, which is always complained of to a greater or less degree, an enema consisting of bromid of sodium or potassium (1 dram) and chloral (from 20 to 30 grains), in addition to the constant and tactful attention of a kind and gentle nurse, usually suffices to afford relief. In the majority of cases that do well very little pain is complained of after the expiration of the first twenty-four hours.

With regard to the *special after-treatment* of cases operated upon, they may, for convenience, be classified as follows: (1) Simple uncomplicated cases in which the abdominal wound is closed at the time of operation; (2) cases in which glass or rubber drainage is used; and (3) cases in which gauze is introduced into the peritoneal cavity, either for purposes of drainage or for the protection of the general peritoneal cavity.

1. In simple uncomplicated cases, if the temperature and general condition of the patient show no abnormality, the wound does not require attention until the lapse of a week, when the dressing should be removed. If there be no evidence of stitch irritation, the sutures may be permitted to remain undisturbed for two or three days longer, when they should be removed and a simple sterilized gauze dressing should be applied. The patient may be allowed to leave the bed at the end of twelve days or two weeks when the incision has been a small one. For the first week or ten days after the patient moves about, the abdominal wall should be supported by an ordinary circular bandage. I have stated elsewhere that I do not consider abdominal supporters of much value, except, perhaps, when the incision has been unusually large. A sudden rise of temperature or a decided increase in the local pain, with distention, necessitates immediate changing of the dressings and a careful search for the source of irritation. Stitch abscesses should be opened and treated on general principles. If pus should form, the case alters its aspect and becomes one of the following.

2. Cases in which glass or rubber drainage has been employed require stimulation, as they are, of course, suppurative. This should consist of strychnin, whisky or brandy, and champagne. If the patient is greatly depressed, as a consequence of prolonged suppuration, the judicious use of normal salt solution, by enemas, hypodermoclysis, or intravenous injection, will often be found of the greatest utility, and will materially accelerate the patient's improvement. In some of these cases it will be found necessary to continue the use of stimulants, tonics, and especially nutritious diet, for a considerable time.

3. In cases in which gauze drainage has been employed the external dressing should not be disturbed until the third or fourth day, unless it has become very much soiled by the discharges from the wound. In case it does become soiled, it should be immediately changed, and in some cases it may be necessary to do this once or twice daily. At the end of the third or fourth day, or later, as the case may be, the pieces of gauze within the peritoneal or abscess cavity, or both, are removed. They should first be softened with copious applications of warm five per cent. boracic acid solution or normal salt solution, and ample time should be spent in removing them. Unless this be done most carefully, the delicate protective adhesions may be torn and the bowel or omentum may be dragged into the wound. Even when the greatest care is exercised this sometimes occurs. If it does, the bowel or omentum should be replaced and held in position by pieces of sterile gauze until the remaining gauze has been removed. The cavity should then be repacked in such a manner as to retain the bowel or omentum which had become disengaged. After the removal of the gauze the cavity should be gently irrigated with boracic acid solution alone, or with boracic acid and carbolic acid solutions, or with sterile distilled water or sterile normal salt solution. If the cavity is small and is found to be clean, the sutures that were left untied at the time of operation may be tied and the wound may be closed. If it be thought best not to close the wound, the untied sutures should be removed and the wound permitted to heal by granulation. Later, when the wound is well filled with healthy granulations, cicatrization may be hastened by the introduction of secondary sutures.

In the vast majority of cases involvement of the general peritoneal cavity does not occur. Occasionally, however, it is found at the time of operation, or it develops after the operation, and in either case demands the most vigorous treatment. In such cases I deem it best to withhold all nourishment for the time being, to apply ice-bags to the abdomen, and to secure free purgation by the use of calomel. Salines, of course, are better adapted for thorough drainage of the engorged peritoneal vessels, but, unfortunately, in these conditions the stomach will often not tolerate them. They may prove of service in some cases, but the best results will generally be secured by the other line of treatment, as indicated.

When constitutional conditions demand treatment, nutritious enemas, consisting of peptonized milk, bouillon, eggs, etc., will be found of service.

In those cases in which for some reason operation was not undertaken during the acute stage of the attack, and in which the patient seemingly recovers,—in reality the appendicular inflammation has become chronic,—the appendix should be removed between the attacks of acute inflammation: that is, when the disease is more or less quiescent. This statement applies to all cases of so-called subacute, relapsing, recurrent, and chronic appendicitis. There can be no question that an appendix that has once been the seat of inflammatory disease is a source of danger to the individual; it may suddenly develop a most serious acute exacerbation at any time. It should, therefore, be removed. The mortality from the operative treatment of subacute and chronic appendicitis is exceedingly small. In cases of so-called recovery the patient is usually more or less of a chronic invalid, who is troubled with indigestion, associated with constipation or diarrhea, and who rightly dreads the occurrence of another attack of acute appendicitis. It must also be borne in mind that there are certain results of the inflammation that are not manifest to the patient, such as bands of peritoneal adhesions; that these may cause mechanical obstruction or chronic inflammation of the intestine, etc.; and that they may inaugurate their deleterious consequences at any moment. In addition, the mass of inflammatory exudate and the adhesions frequently unite the appendix so firmly to the surrounding tissues that the difficulties attending its removal are much increased.

In those cases of subacute or chronic appendicitis in which the patient can not submit to immediate operation he should be cautioned to lead a regular, hygienic, and abstemious life, and to avoid dietetic and other indiscretions. Attention must be directed to the clothing, which should be changed to suit the varying conditions of the weather, and which should afford sufficient protection without exciting the skin to undue activity. The feet especially must be protected against the inclemencies of the weather. It is important that the food be selected with particular care, and that it be simple, readily digested, and leave little residue in the intestinal tract. All coarse foods, such as grits, coarse oatmeal, tough meats, etc., must be scrupulously avoided. Not only must the food be selected with care, but it should be taken at regular intervals, and should always be eaten slowly and thoroughly masticated. There can hardly be much doubt that the lunches of many business people—which frequently consist of indigestible food, taken at irregular hours, and insufficiently masticated—are a fruitful source of recurring attacks of appendicitis. The condition of the teeth must be examined into, and, if necessary, a set of false teeth should be provided. Regular action of the bowels must be insisted upon. This may be best accomplished by the cultivation of regular habits in this particular, whether there be an inclination to stool or not; by eating various laxative fruits, such as prunes, oranges, apples, dates, figs (there is no reason for the supposition that the seeds of figs and of other fruits lead to appendicitis), etc.; and by the judicious administration of aperient waters and other laxatives, and of enemas, if occasion require. The latter should be avoided as much as possible, and attention should be directed rather to the medicinal treatment, if necessary, of the intestinal indigestion, which is commonly the basis of the intractable constipation in these cases. It must be borne in mind, however, that such intestinal indigestion is sometimes engendered or maintained by the associated appendicitis, and that relief can not be expected in some of these cases until the offending appendix is excised. Various intestinal antiseptics are believed by some to exert a beneficial influence in preventing attacks of appendicitis in chronic cases, but this is not in accordance with my observations. Moderate exercise may be permitted, but violent exercise must be prohibited.

COMPLICATIONS AND SEQUELS.

The complications and sequels of appendicitis are many and various. Some of them—as circumscribed peritonitis, for instance—are in many respects a part of the disease rather than a complication; others, as diffuse peritonitis, gangrene of the bowel, abscess of the liver, etc., are of much more serious moment, and materially interfere with the prompt recovery of the patient or determine a fatal issue; others, which may or may not pertain to either of the foregoing classes, are of importance as they render more or less difficult the proper surgical treatment of the affection.

Among the last-named class may be mentioned difficulties in effecting complete anesthesia. It is not an uncommon occurrence to encounter patients in whom it is almost impossible to secure complete relaxation of the abdominal muscles. In such cases the intestines are likely to present in, or protrude from, the abdominal wound at most inopportune moments. The addition of a few drops of chloroform to the ether, however, will generally overcome this tendency and effect complete muscular relaxation.

The condition of the abdominal wall is often a serious impediment to the dextrous removal of the appendix. If, on account of the excessive deposition of fat, the abdominal wall is very thick, the difficulty of locating the cecum and appendix and of bringing them within the field of vision may be considerable. This, however, can usually be overcome by enlarging the incision. I can recall cases in which the abdominal wall was from four to five inches in thickness, and in which the cecum and appendix were firmly united to the floor of the right iliac fossa by rather dense adhesions. In one of these cases the appendix, which was freed with difficulty on account of the excessive thickness of the abdominal wall, was so friable that it was torn loose from its cecal attachment in the endeavor to ligate it. The remaining stump could not be brought within the limits of the abdominal wound because of the firm adhesions of the cecum. The stump was then caught with a pair of hemostatic forceps and a ligature was thrown about it below the forceps and tightly tied. The stump was then invaginated into the wall of the cecum, and, by using a short curved needle in a needle-holder, it was covered by stitching the wall of the cecum over it.

Unusual situations of the appendix often cause considerable difficulty in the removal of the organ. I have frequently encountered cases in which, such were the anatomic conditions, that at first sight the organ might be supposed absent. In these cases it was finally found in intimate association with, and beneath the peritoneal covering of, the cecum—the one layer of serous membrane being reflected over both. (Plate v.) If under such circumstances a collection of pus surround the appendix, the determination of the situation of the organ is sometimes exceedingly difficult and its removal is particularly arduous. In the event of such conditions it is advisable to cut through the external layer of the meso-colon in order to gain free access to the appendix. This procedure reduces to a minimum the danger of infection of the general peritoneal cavity.

The appendix is sometimes found embedded in a great mass of fibrinous exudate. If this can not be readily removed, its thickest and firmest portion, which usually corresponds with the seat of primary disease of the appendix, should be incised, whereupon the appendix will be readily detected. Again, the appendix may be so rolled up in a fold of the great omentum that it is impossible to define its outline. In these cases it is proper to ligate and cut away the omentum along its attachment to the appendix, after which the appendix itself can usually be freed with facility. This method insures control of hemorrhage from the omentum and permits of ready manipulation of the appendix.

A very fat meso-appendix, unless properly treated, often complicates the removal of the appendix, especially by giving rise to troublesome hemorrhage. A fat meso-appendix is always friable, and is likely to be torn during the operative manipulations attending the removal of the appendix, especially when the application of the ligatures is undertaken. It is best to divide a fat meso-appendix into sections and to cut away each portion as the ligatures are tightened. This procedure minimizes the danger of laceration and consequent hemorrhage.

At times there is necrosis or gangrene of the apex of the cecum. If such be the case, it will often be found that it is impossible to secure any tissue sufficiently healthy to retain sutures introduced for the purpose of closing the opening. An attempt should be made, however, to close it by the introduction into the cecum, to the side of the necrotic area, of sutures so placed as to include tissue as healthy as is possible. Too much tension upon the sutures must be avoided. When the perforation approaches closely the ileo-cecal valve, great care must be exercised to avoid encroaching too much upon this orifice. When the cecum can not be closed securely, the great omentum may be carried down and a portion of this made to serve as a flap to reinforce the sutured area; or if a large meso-appendix be present, it may be utilized for the same purpose. I have frequently done this with good results. In certain cases it will be found absolutely impossible to close the gangrenous area. All that can be done under such circumstances is to wall off the general peritoneal cavity with gauze, and to leave the gangrenous area *in situ*. In a few days the sphacelus will be cast off, with the formation of a fecal fistula, which may be closed at a subsequent operation, if repair does not take place spontaneously. In many of these cases the surgeon's ingenuity is taxed to the utmost, and the greater his experience, the more likely are his endeavors to be attended by a successful outcome. It is well to bear in mind that if the gangrenous area be invaginated, and the abdominal wound be immediately closed, the development of a fatal peritonitis is a most likely event.

In a considerable number of cases the appendix is found adherent to one or another of the abdominal or pelvic organs. In these cases great care must be exercised in the removal of the organ because of the liability of the occurrence of hemorrhage. Especial care is necessary in those cases, fortunately rare, in which the appendix is discovered adherent to the iliac vessels. After detachment of the appendix the vessel itself must be carefully investigated, as in some cases it has been found to be the seat of necrosis or more or less gangrene. If such be the conditions, and the weak point in the wall of the vein is not reinforced by peritoneal flaps, sudden fatal hemorrhage may ensue.

Of the complications that pertain to the disease itself, peritonitis is the most frequent, and in some respects the most important. As is evident from a consideration of the pathology of appendicitis, circumscribed peritonitis is a part of the disease rather than a complication. The pathogenesis and the morbid anatomy of this have already been discussed in the chapter on the pathology. Diffuse or generalized peritonitis, though hardly to be considered apart from the general disease, is more of a complication, and always most seriously prejudices the patient's recovery. But this also has already been discussed.

Among the most common and most important complications of appendicitis are various lesions of the gastro-intestinal tract. Obstruction of the intestine consequent upon contraction of peritoneal bands is one of the most common. This is most likely to occur in chronic cases, and in some cases the first symptoms complained of may be those of intestinal obstruction. These peritoneal bands should be sought for, and, if detected, should be relieved at every operation for appendicitis. Sometimes these adhesions develop after operation, and to such marked obstruction of the intestine may they give rise that a secondary operation may be necessitated for their removal. In a certain proportion of cases of acute appendicitis with periappendicular abscess, within a few days, or even hours, after the operation the patient becomes the subject of paroxysms of abdominal pain associated with difficulty in the evacuation of the bowels—and these occur despite the fact that large doses of saturated solution of Epsom salts may be regularly administered. This condition is the consequence of adhesions that probably have not been broken up at the time of operation. Its possible occurrence argues for thoroughness of the primary operation: that is, removal of the appendix, the separation of adherent coils of intestine, the clearing away of all bands of adhesions, etc. In the presence of such a condition it is essential to continue purgative treatment, and to permit the patient liquid diet only. If the symptoms persist, and particularly if there develop vomiting and the appearance through the abdominal wall of coils of intestine in active peristalsis during the paroxysms of pain, operation must be performed without delay and the adhesions relieved. At times the appendix itself acts as the constricting band, being curled about a portion of the intestine—usually the cecum. The appendix is most likely to be at fault when it holds some anomalous position. I have seen a case in which a peritoneal band, the result of chronic appendicitis, was stretched between the appendix and a Meckel's diverticulum. Obstruction resulted from a coil of intestine becoming engaged beneath this band.

Among the most important, and sometimes intractable, accompaniments of appendicitis is mucous or membranous colitis. In some such cases the obtruding symptoms are purely those of the colitis, and the diseased condition of the appendix is for a long time unsuspected. At times there are also added manifestations of indigestion, and at other times the most aggravated neurasthenia. Indeed, it is quite certain that a not inconsiderable percentage of neurasthenics suffer from chronic appendicitis. The condition of the appendix is not determined, and the most persistent treatment directed toward the relief of the neurasthenic symptoms is not followed by the desired benefit. The following is an illustrative case:

Miss P., aged forty-four years, was referred to me with the following history: For the past three years she had suffered from a mucous diarrhea, which had been attributed by various physicians to entero-colitis, dysentery, etc., and had been treated by the most diverse methods—from bismuth by the mouth to quinin and nitrate of silver by the rectum. Upon admission to the German Hospital she was markedly neurasthenic and much emaciated. Her bowel movements averaged from four to eight daily. They contained mucus, shreds of mucous membrane, and blood. Upon careful examination the appendix was found enlarged and was painful upon pressure; there was no rigidity of the abdominal wall. She gladly consented to operation, in the hope of obtaining relief, and the appendix, when removed, was found to present typically the lesions of catarrhal inflammation. Recovery was uninterrupted. The bloody and mucous stools, the neurasthenia, and the emaciation, however, did not markedly improve for over three months after the operation, when her symptoms rapidly abated. She gained flesh, and within one year she considered herself entirely cured. The digestive functions were performed normally, the neurasthenia had disappeared, and she had increased in weight over twenty pounds.

The removal of the diseased appendix, which is probably the primary cause of the train of symptoms as just narrated, —leading, as it does, to inadequate intestinal digestion, colitis, etc., or to mal-assimilation, auto-intoxication, and neurasthenia,—is of utility only in that it removes the cause of these symptoms and the danger to life which constantly threatens these patients. The morbid conditions to which the diseased appendix has given rise then require treatment, and it is often months or a year or more before decided improvement is manifest. Restoration to health—that is, immediate improvement in the inflammation of the colon or of the neurasthenia —must not be expected to follow directly upon the operation.

Constipation sometimes follows an operation for appendicitis. It may be quite intractable, and may give rise to the most unpleasant manifestations. For the relief of this, strict hygiene and appropriate diet must be enjoined, and in some cases a systematic course of laxative remedies will be found most serviceable. The action of these will be much facilitated by regular habits in the evacuation of the bowels, by judicious exercise, and, if necessary, the systematic use of hydrotherapeutic baths.

These considerations emphasize the necessity for the physician carefully to examine even mild cases of colitis, mucous enteritis, neurasthenia, and allied disorders for possible appendicitis. It is rational to expect that the sooner the cause of these various ailments is recognized and removed, the sooner will relief be afforded and disagreeable and annoying sequels alleviated.

Other important intestinal complications of appendicitis are gangrene of a portion of the bowel, which is uncommon. More frequently the appendix having formed adhesions with, produces necrosis of, the bowel and perforates into it. Instances of perforation into the duodenum, ileum, cecum, colon, sigmoid flexure, and rectum have been reported. An analogous condition of intestinal perforation sometimes arises from evacuation into the bowel of a peri-appendicular abscess. If such be suspected, or if the appendix or a peri-appendicular abscess be in close association with a portion of the bowel, the condition of the latter must be carefully investigated, and the treatment appropriate in each case should be diligently carried out.

It has already been stated that a diseased appendix or a collection of pus about the appendix may form an association with, and give rise to necrosis of, the iliac blood vessels. The vein is more likely to become involved in the inflammatory process than the artery, but in either case, if the necrotic process be extensive, rupture of the vessel and fatal hemorrhage may ensue. It is more common, however, for an arteritis or a phlebitis to occur. This results in thrombo-arteritis or thrombophlebitis, which may be mechanical or infective, and may give rise to infective or noninfective embolic processes. Scheibenzuber has reported an unusual case of embolism of the left anterior tibial artery with consequent gangrene of the leg, and Bérard a case of obliteration of the right crural artery the result of arteritis. Of the venous involvements may be mentioned inflammation of the right iliac vein, of the right femoral vein, of the left femoral vein, of the mesenteric veins, and of the portal vein. These inflammations are generally infectious, and give rise to infectious embolic processes, of which the most important is hepatic abscess. The following is an illustrative case:

A. T., a white male, aged twenty-two years, and a bartender by occupation, had a negative family history. His previous personal history was also negative—he had had only the ordinary diseases of childhood. During the eighteen months prior to first observation he had had three or four attacks of colic, attended by vomiting. There was no recollection of localized pain. The attack usually subsided within a few days and he was able to return to his work.

On March 1, 1895, he developed a sore throat, which was accompanied by stiffness of all his extremities and was followed by excruciating griping pains in the epigastrium, which were increased by deep inspiration. He had chills, fever, and sweats at irregular intervals; headache and backache; his appetite was fair and his bowels were loose. When seen by his attending physician, on March 15th, he presented the following symptoms: Temperature, 103.4° F.; pulse-rate, 96; hectic flush on the cheeks; extreme pain and tenderness and slight tympany in the epigastrium. His tongue was thickly coated; his heart and lungs were normal. His urine contained a trace of albumin and a few granular casts. Blood examination revealed the normal number of erythrocytes and leukocytes, and the normal percentage of hemoglobin. Microscopically, a few intracellular organisms, resembling the hematozoa of malaria, were detected. During the succeeding night he had a severe chill and profuse sweating. The following morning at 5 A.M. his temperature was 98° F. and his pulse-rate was 80. A serous diarrhea then set in. Quinin was administered without relief, and no change in his symptoms was noted until March 19th, when, with a morning temperature of 99.6° F., his pulse-rate was 104. His pulse was irregular, there was general abdominal distention, accompanied by marked tenderness and tympany, and a general peritonitis had evidently supervened. The diarrhea continued, the pulse was rapid and irregular, and the patient grew weaker and died April 4th. At necropsy, performed eight hours after death, there was detected a general peritonitis due to a ruptured abscess of the liver. The appendix was perforated and was embedded in a mass of necrotic adhesions. There was purulent inflammation of the portal vein which extended into the liver substance. In the upper part of the right lobe of the liver there were numerous embolic abscesses, one of which, situated near the surface, had ruptured beneath the diaphragm.

This case, which came under my observation at necropsy only, is reported: (1) To demonstrate the importance of excluding primary appendicular inflammation in the diagnosis of all intra-abdominal affections, particularly when pain and tenderness are not referred to the right iliac fossa; (2) to show the prevalence of pylephlebitis and abscess of the liver as sequels of appendicitis; and (3) to emphasize the value that should be attached to a history of previous attacks of colic with gastric irritation, as indicating early involvement of the appendix—from which as an infectious focus other organs may subsequently become involved.

These hepatic complications of appendicitis are of the utmost importance and merit the careful consideration of the physician. Indeed, in some cases abscess of the liver, which may be either single or multiple, may so mask the symptoms of the primary appendicular disease that the necropsy alone reveals the purulent focus in the appendix. Pylephlebitis and hepatic abscess, formerly regarded as of infrequent occurrence, are now recognized to be much more common. They constitute the most serious, and almost necessarily fatal, complications of appendicitis. It is not only in cases of appendicitis with extensive peri-appendicular suppuration that these complications may be encountered, but they may be met also in less serious conditions—in some cases of severe interstitial appendicitis and in other cases with circumscribed ulceration or gangrene. When we consider the freedom of the anastomosis of the veins of the mesentery, it is not strange that abscess of the liver and other complications should occur. Such is the importance of these complications that they have been dignified by a special designation by Dieulafoy, who speaks of them as "la foie appendiculaire."

At times a peri-appendicular abscess may burrow upward behind the liver, either through or beneath the diaphragm, and may finally rupture into the lung, the pus being expectorated. The following is an illustrative case:

R. S., a male, aged nineteen years, was admitted to the German Hospital, on August 25, 1895, and the following history was elicited: He had always enjoyed good health until three days prior to admission, when, after a hearty meal, he commenced to complain of pain in the epigastric region. This was attended by vomiting, which afforded no relief. The pain increased in severity and became localized in the right iliac fossa, which was markedly tender on pressure. The vomiting finally ceased, but nausea persisted. The patient considered himself afflicted with an ordinary attack of intestinal colic, and did not summon medical aid until the pain became unbearable. He was sent immediately to the hospital, where, upon admission, his temperature was found 102° F.; his pulse-rate, 94; his abdomen slightly distended and rigid, especially upon the right side, where tenderness was most marked. He complained of generalized abdominal pain.

A diagnosis was made of appendicular abscess.

Ice-bags were applied to the abdomen and saline purgatives were administered. Some abatement of the pain and tenderness resulted. Although operation was strongly advised, it was absolutely refused by the boy's parents. At this time his temperature ranged from 99° to 99.8° F.; his pulse-rate, from 84 to 100. He was, however, fairly comfortable, despite occasional nausea and vomiting and the continuance of abdominal tenderness. He remained in this condition until the fourth day after admission (the seventh day of the attack), when he suddenly grew worse, his temperature rising to 104° F. and his pulse-rate to 120 a minute. He vomited continuously, became dyspneic, and expectorated large quantities of fetid, muco-purulent matter, tinged with blood. Examination of this revealed no tubercle bacilli. The patient became exhausted and died nine days after admission to the hospital.

At necropsy a perforated appendix, pointing north and lying just below the diaphragm, was found. The abscess surrounding the appendix had perforated through the diaphragm into the lung, which revealed some gangrenous areas. The expectorated matter was evidently some of the peri-appendicular abscess.

In addition to this case I have encountered several other cases in which the pus from a peri-appendicular abscess was evacuated through the mouth. At times there results a purulent pleuritis, which may or may not be accompanied by inflammation, abscess, or gangrene of the lung. A subphrenic abscess is not infrequently an early process in such a train of events, and this may result from either intraperitoneal or retroperitoneal suppuration. If the latter, there first ensues a lumbar or perirenal abscess, of which a considerable number of cases have been observed. This is the consequence of infection by contiguity or of metastasis via the blood vessels and lymphatics going to that region. Suppuration of the kidney, of its pelvis, and of the ureter have also been encountered, and these conditions have been noted in addition to the renal manifestations, such as albuminuria and casts in the urine, etc., which are so frequently observed in cases of appendicitis. On the other hand, vesical complications may be prominent. Vesical irritability as an indication of the association of the diseased appendix or of a peri-appendicular abscess with the bladder has been noted elsewhere. In addition to this, there may arise a purulent cystitis as a consequence of the migration of the bacterium coli commune or other bacteria through the apparently intact bladder wall. The occurrence of the rupture of a diseased appendix or of a peri-appendicular abscess into the bladder has also been referred to elsewhere.

Appendicitis may complicate a hernia, and, if the latter be strangulated or if a strangulation be suspected, the symptoms of the appendicular inflammation may be entirely obscured, as is illustrated by the following case:

Mrs. X., aged forty-two years, was admitted to the German Hospital and the following history was elicited: Two days prior to admission she had been attacked with general abdominal pain, which was associated with vomiting and marked constipation. The attending physician detected a mass in the right inguinal canal which the patient stated was an old hernia. The mass was tender on pressure and was irreducible by taxis, even under anesthesia. The patient steadily grew worse, and the following morning she was again etherized and another and a futile attempt was made to reduce the mass. She was then removed to the hospital, where I saw her. The mass was tender and was evidently inflamed; the abdomen was distended and the bowels were absolutely constipated; vomiting occurred frequently. Incision over the tumor showed that it was the sac of an old hernia which was not the seat of inflammation. By extending the original wound the peritoneal cavity was opened and a generalized purulent peritonitis was disclosed. The appendix, which was extensively diseased, was removed. The peritoneal cavity was thoroughly irrigated, drainage introduced, and the wound closed. The patient did not rally, and died eighteen hours after the operation.

The original site of the inflammation was undoubtedly the appendix, but the hernia and the mass to which it gave rise in the right inguinal canal had misled both the attending physician and myself.

Not only may appendicitis be mistaken for a strangulated hernia, and vice versâ, but the appendix may be found in the sac of the hernia, of either the inguinal or femoral variety. It may remain in the sac for a number of years unattended by symptoms of appendicitis, and may only be detected accidentally at necropsy or at operation for the cure of the hernia.

There sometimes occurs an abscess of the abdominal wall consequent upon an appendicitis, but such is rather rare. The following is an illustrative case:

A boy, aged thirteen years, with a history of three attacks of appendicitis, was referred to me by my friend, Dr. P. F. Moylan. During his last attack the boy had been attended by Dr. Moylan, who said to me that at the time of his first visit there was a general peritonitis, which was attended by so much distention that he was unable to make out by examination the cause of the peritonitis. There was apparent recovery after this attack.

At operation, performed by making an incision through the right semilunar line, a cheesy mass situated beneath the transversalis muscle was disclosed. The peritoneum beneath this collection had been destroyed and the mass was limited posteriorly by the great omentum. The cheesy material was cureted away and the cavity was antisepticized. The diseased portion of the omentum was ligated from the remaining healthy portion and excised. The cecum contained two perforations, which were disclosed after the removal of the diseased and adherent omentum. The appendix was post-cecal and embedded in a mass of coagulated lymph, and was perforated at its base. The pelvis contained a collection of pus, which was limited by adherent coils of intestine.

The patient recovered.

Among the remaining complications and sequels of appendicitis may be mentioned pyemia and disease of the female genitalia. The former may be attended by the development of single or multiple abscesses in various regions of the body, such as the kidney, spleen, lungs, brain, etc. In some of these cases also a septic or croupous pneumonitis may supervene and induce a rapidly fatal termination; in other cases there may occur an acute nephritis of severe type. The development of an acute endocarditis is by no means rare.

Diseases of the female genitalia occurring in association with appendicitis are of great frequency and importance. Appendicitis of every variety has been found associated with almost every pathologic condition of the pelvic organs. The sequence of events varies in different cases: at times the lesions commence in the appendix and subsequently involve the genitalia; at other times the inflammatory phenomena are inaugurated in some portion of the genitalia and later implicate the appendix. From rather extensive observation it has seemed to me that the former is much the more common, (1) because wide-spread pelvic lesions are particularly likely to be encountered in young women and girls in whom no history or sign of external infection can be detected; (2) because of the excessive virulence of appendicular pus and the especial faculty it possesses of inaugurating purulent processes in other portions of the body; and (3) because the initial symptoms point rather to disease of the appendix than to disease of the genitalia. Although the diseased processes in individual cases may commence in the genitalia, the manifestations of appendicitis may be so prominent that the symptoms of uterine, tubal, or ovarian disease are obscured, and are revealed only by operation or necropsy.

When a peri-appendicular abscess occupies the pelvis it usually results from an ulcerative or gangrenous inflammation of an appendix that points due south or southeast. In these cases the distal extremity only of the organ may be affected, but it is usually in close relationship with one of the pelvic organs. The pain in these cases is usually left-sided, and the abscess formed is of moderate size only. For these reasons there is great liability of confounding the conditions with disease of the pelvic organs, and errors in diagnosis are rendered still more likely because of the rapid formation of firm adhesions that limit the abscess to the immediate vicinity of the sigmoid flexure, the rectum, or the bladder. The bladder and sigmoid flexure are often perforated, and two of the most distressing cases that have come under my observation were of this character. One was a vesico-intestinal fistula in a young man, from whom feces passed through the urethra; the other was in the person of a young girl, with a similar condition, who passed flatus through the urethra.

I have frequently been impressed by the fact that in many of these cases there is a tuberculous family history but no demonstrable tuberculous lesions in the patient. The underlying condition may thus be not only one of diminished power of resistance to the influence of agents provocative of acute inflammation, but also, in some instances at least, a mixed infection, the consequence of dormant tubercle bacilli being started into activity by infection with appendicular pus. Be this as it may, especial emphasis must be directed to the clinical importance of these pelvic lesions—conditions in which both the tubes and the ovaries, together with the appendix, are involved in phlegmonous inflammation. Surgically, they present difficulties that are often insurmountable. The various organs are covered by great masses of fibrinous or fibrinopurulent exudate in which one or more abscesses may be encountered. There are also encountered dense adhesions that have so devitalized the tissues that the slightest traction is likely to lead to rupture of the bladder or the intestine. I have seen a case—that of a young man who suffered an attack of acute appendicitis, from which he apparently recovered without operation. Later his right chest filled with fluid, which aspiration indicated to be appendicular pus—probably the consequence of a subdiaphragmatic abscess. A rib was resected and he improved. Still later the sigmoid flexure was perforated and the pelvic abscess further evacuated itself through the rectum. These conditions not only possess a present danger, but also a most serious remote danger, in that they exhibit a most persistent tendency to recur, a tendency which it is sometimes beyond the power of human skill to overcome. As already mentioned, intestinal obstruction and strangulation may ensue. In addition, the omentum frequently becomes attached to the parietal peritoneum, and, by its efforts to free itself, as well as by certain movements, such as coughing, sneezing, deep inspirations, etc., intense pain may be provoked. Indeed, in some cases only slight adhesions are sufficient to constitute a source of considerable trouble and complaint.

Pregnancy also may complicate appendicitis, and vice versâ, and is always a cause of anxiety. If appendicitis occurs during the early stages of gestation, abortion frequently results. Whether or not this results, a pregnant woman who is attacked by acute appendicitis should be operated upon as soon as practicable after the onset of the initial pain. The removal of a diseased appendix during pregnancy is attended by few, if any, risks to either mother or fetus, apart from those dangers that may attend any operation. The usual risks of leaving a diseased appendix in the abdominal cavity are much increased by the pregnant state, and the evil consequences of a subsequent attack of appendicitis, such as perforation and gangrene, are correspondingly augmented. I have seen a number of cases of appendicitis in pregnant women in whom, as a consequence of delay in operation, the right uterine adnexa have become infected, and most serious conditions—in some instances death—have ensued. The earlier the operation, the less the likelihood of infection of the right tube and ovary, and the less likely, therefore, the development of serious complications. The wisdom of early operations is especially evident from the fact that I have never had abortion to occur in pregnant women upon whom I have operated for acute appendicitis unless the right uterine appendages were involved in the disease. Appendicitis also may complicate parturition and the puerperium, and in either condition is of serious moment. The establishment of a differential diagnosis between antepartum or postpartum sepsis and appendicular sepsis will often tax the resources of the most erudite and experienced.

One of the most important sequels of appendicitis, whether associated with suppuration or not, is fecal fistula. This is of comparative frequency after operations, but there can be no question that the likelihood of its occurrence is much increased by delay in the performance of the operation.

Appendicular fistulas occur as one of two varieties—the internal and the external. In the internal variety the channel of communication, or the fistula, is in direct communication with some hollow abdominal viscus, and is entirely within the abdominal cavity. In the external variety the fistula is in communication with the exterior through the abdominal wall. In the internal variety any of the hollow viscera may be involved—any portion of the intestinal tract, the bladder, the dilated portion of the ureter, etc.; in fact, any of the viscera in close proximity to the appendix. In the external variety there may be but a single sinus, or there may be a number of fistulous tracts with a common external opening. The extent of the lesions and the organ or organs implicated, as a rule, can not be determined until the viscera have been exposed by operative manipulations.

Of external fistulas there are two varieties—the simple and the fecal. Simple fistulas are found in two varieties: (1) those that are the result of an unhealed abscess cavity, and follow the use of drainage. They are merely suppurating tracts that discharge pus, and have a tendency to heal spontaneously. Frequently an infected suture or ligature at the bottom of such a tract (rarely a piece of gauze) is the cause of the delayed healing. (2) Those in which the fistula is in communication with the lumen of an appendix from which there has never been discharged anything but mucus. This type of fistula is encountered in cases in which the lumen of the appendix has become entirely occluded or obliterated at some point, or in which there has occurred spontaneous separation of the appendix in its continuity. Under these circumstances the terminal or distal portion of the appendix serves as the source of the discharge from the fistula.

There are two varieties of fecal fistula the consequence of appendicitis. Of these, the following may be distinguished: (1) Those in which the fistula is in communication with the lumen of an appendix from which there was at first discharged fecal matter, and later mucus, with occasionally a little fecal material. (2) Those in which the fistula is in communication with the cecum, the ascending colon, the small intestine, or both the small and large intestines. In this variety the fistula may be so extensive as practically to constitute an artificial anus.

The exciting causes of fecal fistulas are those which are active in the production of appendicitis. The destructive activity of pathogenic micro-organisms is responsible for this most distressing condition. As a result of inflammation in and about the appendix, necrosis and softening of adjacent or contiguous bowel occurs. Pus may or may not be present. There are some cases in which pressure necrosis produced by inflammatory lymph results in the formation of a fecal fistula, although pus either is not present or is present in such small amount as to be scarcely discernible. Abscess formation, however, is undoubtedly the precipitating cause of fecal fistula in the great majority of cases. The abscess exerts its deleterious influences because of the necrosis and pressure that attend its formation. The irritation produced by a drainage-tube or that the result of stitches introduced into an inflamed and infiltrated bowel may also be the cause of a fecal fistula. If at operation it be found necessary to insert stitches into an inflamed bowel, especial care must be exercised not to introduce them too closely or to tie them too tight, as inattention to both of these frequently results in the formation of a fecal fistula. In many cases of fecal fistula there will be found a large perforation in the bowel, or it will be found that the appendix has separated in its continuity, and that from the proximal end the contents of the bowel escape. In many cases of fecal fistula persistence in the use of a drainage-tube is one of the most active factors in preventing spontaneous healing. I have seen a number of cases in which removal of a drainage-tube that had been worn for weeks was speedily followed by spontaneous healing of a fistulous tract. In particular, recently I saw in consultation a young man who had already been operated upon twice for appendicitis, and who presented two fistulas. One on the right side discharged bile and feces, and another, on the left side, discharged pus. In the fistulous tract on the right side there was, and had been for some weeks, a large-sized rubber drainage-tube, which extended to the bottom of the pelvis. Removal of the drainage-tube was followed by spontaneous healing of the fistula within a short time.

It is not at all unusual for an appendicular fistula to make its appearance a week or ten days after an operation for acute appendicitis, and one should not dismiss the possibility of such a sequel occurring until the abscess cavity has been in great part obliterated, and even then it may develop.

The following is an interesting case in which I recently operated for the cure of fistula, the result of an attack of appendicitis, which was not recognized until an abscess had formed:

The patient was a young woman, but the operation was not a complete one, in that the appendix was not removed at the time of the evacuation of the abscess. On account of the softened condition of the intestine forming the wall of the abscess cavity, and the appendix being inaccessible, it was deemed advisable not to attempt its removal, but to leave it for excision at a subsequent operation. The abscess cavity was treated by packing. Ten days after the operation the dressings were found to be soiled, chiefly with bile. The fistula not only refused to heal spontaneously, but, in addition, there developed a most painful eczema of the skin surrounding the external orifice of the fistula. All the well-known topical applications proved of no avail. Operation became imperative, but the patient's condition was exceedingly bad. Because of the painfully irritated condition of the skin, all nourishment by the mouth had to be suspended, and nutritious enemas alone were given. The latter provoked irritation of the rectum. The operation was attended by considerable difficulty. There were wide-spread adhesions that bound the cecum to the small intestines and to the region of the gall-bladder, and these necessitated extensive dissection. The fistula was found to involve the duodenum, and called for resection. The former abscess cavity was still present; its interior was lined with a grayish, unhealthy looking, granulating surface, which was stimulated and the cavity was again packed with iodoform gauze. The abdominal wound was closed, except for a short distance, an opening being left to permit of the subsequent removal of the gauze. Two weeks after the operation the patient complained of pain. On removal of the dressings it was found that the fistula had recurred; in fact, that it was worse than it had been before the operation. The matter discharged from the fistula was fluid; and if milk, for instance, were swallowed, it was discharged from the wound a few moments after it was received into the stomach. Bile also escaped through the fistula. Owing to the nature of the fistula and the return of the eczema, another operation was determined upon. The opening in the small intestine was found some distance removed from the previous lesion, and the line of suture of the former operation was still intact. There was found in the duodenum a large opening, through which the contents of the bowel escaped. The entire duodenum was ballooned and very much attenuated. It was excised to the extent of five inches. The bowel was closed by end-to-end anastomosis, and the thinned portion was reinforced by peritoneal flaps. The abscess cavity was again packed with gauze and the abdominal wound was closed except the lower angle, which was left open to afford drainage. This operation was a success. The former abscess cavity soon granulated to the surface and cicatrization was complete in a short time.

In the external variety of appendicular fistula the character of the discharge varies greatly. In some cases a short time after the operation there occurs a complete disappearance of the fecal matter, and the discharge becomes mucous or mucopurulent, and may continue for a long time of such character.

It has been my experience that if the appendix be not removed at the time of the evacuation of the abscess, in the majority of cases it will be found in communication with the fistula. In one case there was a small external opening, not large enough to permit the passage of a probe, which intermittently discharged mucus only. At the time of the original operation it had been noticed that the appendix had become separated from the cecum. Shortly after the operation there developed this fistula, which was treated expectantly, in the hope that it would heal spontaneously. This, however, did not occur. At the secondary operation the remnant of the appendix was found directly attached to the abdominal wall and draining itself through the fistula. A prompt recovery followed its removal.

In another instance, as already referred to, the patient was supposed to be suffering originally from a perinephritic abscess, which was evacuated and drained. Three or four weeks after the wound had healed the patient began to complain of pain in the region of the loin, and also of pain in the region of the appendix.

He was then admitted to the German Hospital. While being placed on the operating table under the anesthetic, there was detected a distinctly fecal odor, as though the patient had had an evacuation of his bowels. On exposing the site of the former operation there was found a free discharge of fecal matter through an opening in the cicatrix of the former operation that had broken down. This region was carefully protected, and the patient was placed upon his back. An incision was then made over the region of the appendix, which, when exposed, was found to be post-cecal and to be in communication with the fecal fistula in the loin. The appendix was much dilated, and thus permitted of the passage through it to the fistula of the contents of the cecum. The appendix was removed, the abdominal wound closed, and drainage introduced into the former fistulous tract. Complete recovery ensued.

The internal variety of fistula, the result of the evacuation of an appendicular abscess into a hollow viscus, is believed by some to be a fortunate termination of such a case. It has been my lot to have seen many cases in which the result has been most disastrous. In one case there was a fistulous communication with the bladder, which eventually cost the patient his life. In another case the fistulous tract emptied into the dilated portion of the ureter and fecal matter was discharged into the ureter and escaped externally through the urethra. In another case the fistulous tract communicated with the air-passages. The least unfortunate variety of internal fistula is that in which the communication is with the cecum or ascending colon. I have operated for recurrent appendicitis in which, during the last attack, the abscess had evacuated spontaneously through the colon, resulting in the formation of this variety of fistula.

When the fistula is in communication with another portion of the intestinal tract, it has in many instances been the direct cause of an intestinal obstruction. The fistulous communication between the cecum and an adjacent loop of small bowel has acted as a band, beneath which another loop of intestine has become engaged, and later strangulated.

The constitutional manifestations of fecal fistulas are evidenced by gradual loss of strength. If the fistula involve the upper portion of the small intestine, there occurs rapid loss of strength and weight, on account of the loss through the fistula of the contents of the bowel containing the necessary elements of nutrition.

The treatment of appendicular fistulas of the external variety varies with the individual cases. It is well, however, to permit nature to attempt a cure. The surgeon's attention should be directed to maintaining thorough cleanliness and to regulating the diet. Frequently a fistulous tract will heal spontaneously if the diet be solid food and the bowel contents be kept rather hard. It is not wise to use a syringe frequently to irrigate the tract. If the fistula persists after the lapse of a reasonable time, operation offers the only hope of cure.

The operative treatment of the simple fistula should consist in exploring the tract to ascertain if an infected suture ligature or other foreign body be the cause. If this be so, it should be removed and the tract should be cureted and packed with gauze. This usually suffices to insure a cure. When the fistula or sinus communicates with an unhealed abscess cavity, the mouth of the fistula should be enlarged sufficiently to permit of thorough cleansing and packing. When possible without opening the peritoneal cavity, the mouth of the fistula should be enlarged to a degree to equal the transverse diameter of the abscess cavity at its widest part. This should be followed by thorough cleansing, packing, etc.

The treatment of fecal fistula necessitates opening the peritoneal cavity, removing the appendix (or its remaining portion, as the case may be), and thoroughly breaking up all peritoneal adhesions. When the fistula is in communication with one or more openings in the intestine, closure, preferably by suture, is to be recommended. In addition, transplantation of omental or peritoneal flaps is to be recommended in suitable cases. In some cases it is necessary to perform a greater or less extensive resection of the bowel, with end-to-end anastomosis or lateral implantation or anastomosis. In performing such operations it is my practice to employ no mechanical devices, but to rely solely upon the needle and thread.

Hernia following operation for appendicitis is by no means uncommon. That hernia is more likely to develop when drainage has been employed is readily understood. The frequency of hernia after operation in cases of purulent appendicitis constitutes one of the strongest arguments in favor of early operation in acute cases. That the occurrence of hernia in the absence of pus is influenced by the length of the incision will be generally admitted. In the very early operation and in the interval operation I am frequently able to remove the appendix through an incision merely large enough to allow of the introduction of the index-finger. I have never seen a hernia develop after so small an incision. Again, I do not advise patients who have been so fortunate as to have their appendices removed through so small an incision to wear an abdominal support. In fact, I have little faith in the efficacy of abdominal supporters at any rate. In the event of the development of a hernia, be it ever so small, I strongly advise radical operation for its relief. The pernicious influence upon digestion exerted by hernias, especially by small hernias, is well known. The smaller the hernia, the greater the danger if strangulation should occur.

The operation for the repair of a ventral hernia occurring after an abdominal section—sometimes called an incisional hernia—should consist in the excision of the cicatrix and the careful denudation of the different layers of the abdominal wall forming the sides of the wound. The peritoneum should always be opened, and any existing adhesions uniting the underlying viscera and the parietal peritoneum should be disposed of. Interrupted silkworm-gut sutures taking in all the layers of the abdominal wall, or all exclusive of the peritoneum, should be first introduced, and then the different layers of the abdominal wall should be united by buried tier sutures, preferably kangaroo tendon or chromicized catgut. The tier uniting the muscles should include the overlying sheath or fascial covering. This is one of the most important points to be observed; if it be neglected, we can not be assured of firm union resulting. After the tightening of the tier sutures the interrupted suture should be tied. If the surgeon be disinclined to puncture the skin, he may employ the intracuticular stitch.

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